Main Outcomes	Author, Year Country Study Design Sample Size	Study Characteristics	Results
	TRUNK		
Cobb Angle	Mulcahey et al. (2013) USA Observational N=217	**Population:** 13.2±4.9yr.; Gender: males=127, females=90; Level of injury: Not reported; Level of severity: AIS A=105, B=45, C=30, D=21, Missing=16; Time since injury=4.2±3.7 yr. **Intervention:** None – observational, participants evaluated using the testing guidelines of the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) to determine predictors of worse curve and spinal fusion in neurological scoliosis. *All participants had neuromuscular scoliosis and 24 of the 217 participants underwent spinal fusion due to their progressive neuromuscular scoliosis. **Outcome Measures:** ISNCSCI classification, Cobb angle, motor score.	1. Age of injury ($p<0.0001$) and AIS classification ($p<0.0095$) were the only significant predictors of worse curve when grouped as an entire sample 2. Risk of spinal fusion increased by 11% for every yr. decrease in age at injury 3. Sex, motor score, and neurological level were not predictors of worse curve of spinal fusion 4. Subjects injured before the age of 12 were 3.7 times more likely to require a spinal fusion than those injured after age 12 (95% CI, 0.31-44.64)
ISNCSCI	Mulcahey et al. (2011) USA Repeated Measures N=236	**Population:** Mean age=14.5±4.2yr.; Gender: males=109, females=72; Level of injury: Not reported; Level of severity: Complete=97, Incomplete=84; Time since injury=5.0±4.4yr. **Intervention:** None – observational, participants given the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) to test interrater reliability. Subjects underwent 4 examinations by 2 raters: sensory tests (in prick (PP) and light touch (LT)), a motor test (upper and lower extremity motor test (UEM and LEM respectively), and a test of anal sensation (AS) and anal contraction (AC). **Outcome Measures:** 2-way general linear model analysis of variance, interclass correlation coefficients (ICCs) and 95% confidence intervals.	1. No child under 6 was able to complete the INSCSCI in its entirety. 2. 3 of the 18 participants in the 0-5-yr. age group the PP(n=2) and motor examinations (n=3). 3. 9 of the 42 participants in the 6-11-yr. age group were unable to complete the entire examination, thus most children 6 yr and older can comprehend the directions for, and participate in the INSCSCI examinations. 4. Interrater reliability for each variable (PP, LT, TM, UEM, LEM, AS and AC) in all 3 age groups was high (ICC: 0.93-0.99) except for AC in the 12-15-yr. age group which showed moderate reliability (ICC=0.88). 5. ICC values for S4-5 dermatome PP and LT were all higher than 0.75, indicating moderate interrater reliability across each age group when examined as a function of age. 6. When analyzed as a function of type of injury (tetraplegia/paraplegia), interrater reliability at each age group was moderate to high (ICC: 0.89-0.99). 7. Interrater reliability for classification of severity and type of injury was high (ICC≥0.92 and ICC≥0.92 respectively).
	STAND		
PEDI SCIM	(Altizer et al., 2017) USA Case Report	**Population:** 23 mo, female, T10 AIS A SCI.	1. PEDI score improved by 6 points (60%) from age 36-54mo. and by 18 points (75%) from age 54-72mo.

	N=1	**Intervention:** Overground supported stepping intervention using a dynamic gait trainer. **Outcome Measures:** Paediatric Evaluation of Disability Inventory (PEDI), Spinal Cord Independence Measure (SCIM), Gross Motor Function Measure (GMFM-66), Developmental Profile (DP-3), Support Walker Assessment Ambulation Performance Scale (SWAPS), 6-Minute Walk Test (6MWT).	2. SCIM score improved over the 3 yr. of intervention (36mo. – 19; 54mo. – 31; 72mo. – 43) but remained well below the median adult score for those with injury at T10 of 63 3. GDFM-66 score improved minimally over 3 yr of intervention 4. DP-3 score demonstrated a continued motor deficit in comparison to age, but also shows progress in physical skills 5. 6MWT change from 54-72mo. was double what was expected from documentation in literature for her age and level of SCI.
PEDI	(Choksi et al., 2010) Observational USA N=32	**Population:** Mean age 10.6±6.2 (1-19) yr; Injury Etiology: Traumatic=24, Non-traumatic=8; Level of Injury: Cervical=18, Thoracolumbar=14. **Intervention:** Inpatient rehabilitation physiotherapy and occupational therapy (3 hr/day). **Outcome Measures:** Pediatric Evaluation of Disability Inventory (*mobility* and *self-care*) via Functional Skills and Caregiver Assistance scales).	1. PEDI mobility (functional skills): ↑24.0±14.7 2. PEDI mobility (caregiver assistance): ↑26.1+21.5 3. All children improved or showed no change on walking-related PEDI items: • Indoor locomotion methods: 8/21 ↑ • Indoor locomotion distance/speed: 11/21 ↑ • Indoor locomotion pulls/carries: 13/21 ↑ • Outdoor locomotion methods: 1/21 ↑ • Outdoor locomotion distance/speed: 12/21↑ • Outdoor locomotion surfaces: 12/21↑
Time using FES	(Moynahan, Mullin, et al., 1996) USA Observational N=5	**Population:** Age: 18.4±1.1 yr; Gender: males=2, females=3; Level of Injury: T4 (n=2), T5 (n=1), T8 (n=1), T11 (n=1); Severity of Injury: AIS A; Orthotics Use: Molded Shoe Insert=4, Ankle Foot Orthosis [AFO]=1. **Intervention:** Hybrid system of implanted Functional Electrical Stimulation [FES] (pulse duration 0-150μsec, frequency 0-50 Hz) with wearable AFO. After implantation, participants completed training for standing and mobility. **Outcome Measures:** Patterns of home and community FES use; barriers and facilitators of use. Assessed every 1-4 wk for 1 yr.	1. The frequency of donning the system ranged 23%-34% of the days surveyed; this is equivalent to donning the system once every 3 to 4 days. 2. The two most common standing activities were "one-handed activities (e.g., painting furniture, changing a car's air filter, pushing a sibling on a swing-set) or reaching" and "standing for exercise or to stretch," accounting for 62% of all reported standing activities across subjects. 3. Maneuvering" was typically performed in areas of the house that were easily accessed by wheelchair. 4. The FES system was used to perform swing-to gait with their walkers around the house, sometimes transferring to other seats. 5. "Standing with others" included showing friends or family standing ability, to take pictures or for hugging. 6. "Transfers" (e.g., for weighing or to transfer into a car) were not widely performed.

			7. "Motivators" for FES use included: being able to do things that would be difficult/impossible otherwise, perceiving a healthful benefit from exercise/standing, having a sense of well-being, and feeling an obligation to stand as a member of the research study. 8. "Barriers" included: not having time to stand or exercise, having difficulty seeing opportunities and reluctant to wear it all day.
Time to complete tasks	(Betz et al., 2002) USA Case Report N=1	**Population:** 13 yr, male, T8 SCI. **Intervention:** Lower extremity implanted Functional Electrical Stimulation (FES) with a Knee Ankle Foot Orthoses (KAFO). **Outcome Measures:** Completion of eight upright mobility activities, scored based on completion time and level of independence: donning, stand and reach, high transfer, bathroom, floor to stand, 6-meter walk test (6MWT), stair ascent, stair descent.	1. Across all time periods, the subject required less time to don the FES system (P<0.0001) and to complete the high reach (P<0.0001), high transfer (P<0.0001), and 6MWT (P=.006) compared with KAFO 2. More time was needed to complete the floor-to-stand activity for FES compared to KAFO (P=0.0001) 3. No time differences were seen between FES and KAFO for the inaccessible bathroom transfer (P=0.507) and ascending (P=0.753) and descending stairs (P=0.164) 4. Subject was able to more quickly complete the sit-to-stand transition (P<0.0001), reach for a videotape on a high shelf (P<0.0001), and return to sitting in the wheelchair (P<0.0001) when using FES 5. Subject preferred FES to KAFO for all activities but floor-to-stand at 2-yr. follow-up
FIM	(Bonaroti et al., 1999b) USA Pre-Post N=5	**Population:** Age: 9 yr.(n=2), 10 (n=1), 18 yr.(n=2); Gender: males=4, females=1; Etiology: Traumatic SCI=4, Non-Traumatic SCI=1; Level of Injury: cervical=2, thoracic=3; Severity of Injury: Paraplegia=5. Bracing for Standing & Therapy: Knee Ankle Foot Orthoses [KAFO]=5. **Intervention:** Hybrid system of implanted Functional Electrical Stimulation [FES] (pulse duration 0-150μsec, frequency 0-50 Hz) with wearable Ankle Foot Orthoses (AFO). After implantation, participants completed FES strengthening followed by sit/stand exercise, and then upright mobility training for 4 weeks. **Outcome Measures:** Completion of eight upright mobility activities, scored based on completion time and level of independence with FES versus Long Leg Braces (LLB): donning, stand and reach, high transfer, floor to stand, 6-meter walk test (6MWT), toilet transfer.	1. When comparing the upright mobility activities between using FES versus LLB, subjects required equal (70%) or less (24%) assistance when using FES compared with using LLB 2. One subject had greater independence using LLB for the *floor to stand* transfer 3. One subject had greater independence using LLB for the 6MWT 4. For each activity in which FES provided greater independence, subjects improved from requiring contact assistance (3 or 4) while using LLB to not needing contact assistance (5 or 6) while using FES 5. There were two subjects who required minimal contact assist (4) with LLB but were independent with FES (6), both for the *stand and reach* activity, and six instances in which minimal (4) or moderate (3) contact assistance was required with LLB and no contact

			assistance (5) was required using FES 6. Two activities, *stand and reach* and *high transfer,* were performed significantly faster with FES 7. When subjects were asked which mode of standing, they preferred: • FES 62% of the time • LLB 27% of the time • No preference 11% of the time
FIM, FST	(Bonaroti et al., 1999a) USA Case Report N=1	**Population:** 11 yr, T10 AIS A SCI **Intervention:** Functional electrical stimulation, Knee Ankle Foot Orthoses **Outcome Measures:** Functional Independence Measure (FIM) and time to completion during upright mobility activities: donning, high transfer, toilet transfer, floor-to-standing transfer, ascend/descend stairs.	1. FIM measurements of bathroom transfer and descending stairs completed significantly faster with KAFO ($p<0.001$ and $p=0.04$ respectively) 2. For the remaining activities there was a trend towards faster completion times with FES, but this was not statistically significant (donning: $p=0.28$; high transfer: $p=0.36$; floor transfer: $p=0.67$; ascending stairs: $p=0.32$) 3. While performing the 10 subset activities of the FST, the subject displayed no significant differences in completion times between the 2 modes 4. Subject was significantly more stable in the static position using KAFO ($p=0.03$) whereas in dynamic testing subject was slightly more stable using FES, but was not statistically significant ($p=0.7$) 5. Ambulation velocity was significantly faster using FES during the 100 feet ambulation ($p<0.001$) and maximum ambulation ($p<0.001$) test but not during energy expenditure testing ($p=0.13$)
	GAIT		
Gait Speed	(Behrman et al., 2008) USA Case Report N=1	**Population:** 4.5 yr, male, C8 AIS C traumatic SCI, 16 mo post-injury. **Intervention:** Body weight support, overground walking. **Outcome Measures:** American Spinal Injury Association Impairment Scale (AIS), Lower extremity motor score (LEMS), gait speed, walking independence, walking index for spinal cord injury II (WISCI-II), number of steps.	1. AIS score remained the same after session 74 2. LEMS score remained at 4/50 at session 74 3. From session 51 to 76 gait speed increased from 0.19m/s to 0.29m/s 4. From session 51 to 76 fastest walking speed increased from 0.3m/s to 0.48m/s 5. WISCI score increased from 0/20 to 13/20 6. At session 33 the child showed multiple non-cued steps 7. From session 49 to 74 the child increased from 926 steps per day to 2488 steps per day
Gait Speed	(Betz et al., 2002) USA Case Report N=1	**Population:** 13 yr, male, T8 SCI. **Intervention:** Lower extremity implanted Functional Electrical Stimulation (FES) with a Knee Ankle Foot Orthoses (KAFO). **Outcome Measures:** Completion of eight upright mobility activities,	1. Across all time periods, the subject required less time to don the FES system ($P<0.0001$) and to complete the high reach ($P<0.0001$), high transfer ($P<0.0001$), and 6MWT ($P=.006$) compared with KAFO

		scored based on completion time and level of independence: donning, stand and reach, high transfer, bathroom, floor to stand, 6-meter walk test (6MWT), stair ascent, stair descent.	2. More time was needed to complete the floor-to-stand activity for FES compared to KAFO (P=0.0001) 3. No time differences were seen between FES and KAFO for the inaccessible bathroom transfer (P=0.507) and ascending (P=0.753) and descending stairs (P=0.164) 4. Subject was able to more quickly complete the sit-to-stand transition (P<0.0001), reach for a videotape on a high shelf (P<0.0001), and return to sitting in the wheelchair (P<0.0001) when using FES 5. Subject preferred FES to KAFO for all activities but floor-to-stand at 2-yr. follow-up
Gait Speed	(Johnston et al., 2005) USA Post Test N=3	**Population:** Age: 17-21; Gender: males=3; Level and Severity of Injury: Motor complete T3-T8; Time since injury: 1.0-1.5 yr; **Intervention:** Functional electrical stimulation (FES) consisting of 22-channel implant stimulator, extension leads and epineural electrodes. Leads emanating from the stimulator include two tresses of nine leads each for stimulation of lower extremity muscles and one tress of four leads for stimulation for bladder and bowel function (parameters: 0.2–8 mA amplitude, 25–600 ms pulse duration, 2–500 Hz pulse frequency per channel). After implantation and immobilization participants completed exercise phase (FES strengthening) followed by lower extremity conditioning, standing and upright mobility training (13 wk). **Outcome Measures:** Completion of eight upright mobility activities, scored based on completion time and level of independence: donning, stand and reach, high transfer, bathroom, floor to stand, 6-minute walk test (6MWT), stair ascent, stair descent.	1. Three of the 52 electrodes placed for lower extremity stimulation experienced changes in the responses of the muscles. 2. Two subjects used a walker with wheels to perform the mobility activities and one subject used forearm crutches. 3. None of the subjects required physical assistance to complete the activities but two required supervision. 4. One individual could not ascend/descend stairs as it was felt to be unsafe for him; several activities could not be performed by another subject secondary to complaints of shoulder pain related to poor scapular muscle control. 5. All subjects reported preferring a swing through pattern for walking as they felt it was faster; two subjects could ambulate up to 20 feet and the third subject up to 75 feet. 6. Just one subject demonstrated positive neuromodulation effects of the bladder; stimulation suppressed reflex bladder contractions acutely thereby reducing vesical pressure. 7. For one subject, low frequency stimulation significantly increased rectal and anal sphincter pressure which reduced time to defecate; compared to bowel management without stimulation, the patient reported greater satisfaction with stimulation.
Gait Speed, TUG, WISCI II	(O'Donnell & Harvey, 2013) Australia Case Report N=1	**Population:** 17 yr, male, T6 AIS C traumatic SCI, 16 mo post injury. **Intervention:** Body weight support treadmill training, overground walking	1. LEMS score improved from 16 to 17 from pre- to post-training and from 17 to 18 from post-training to follow-up

		Outcome Measures: Lower extremity motor score (LEMS), Walking index for spinal cord injury (WISCI II), 6-minute walk test (6MWT), 10-meter walk test (10MWT), Timed up and go (TUG), Pediatric Quality of Life Inventory (PedsQL).	2. WISCI score improved from 6 to 9 from pre- to post-training and remained at 9 at follow-up 3. 6MWT score improved from 67m (1 rest) at pre-training to 76m (no rests) at post-training and further improved to 80m (no rests) at follow-up 4. 10MWT score improved from 32.2s at pre-training to 30.3s at post-training but declined to 33.6s at follow-up 5. TUG score improved from 44.6s at pre-training to 40.1s at post-training but declined to 42.0s at follow-up, remaining improved compared to pre-training 6. Overall PedsQL score improved from 38/92 at pre-training to 23/92 at post-training and remained at 23/92 at follow-up
Years using device	(Vogel & Lubicky, 1995) USA Observational N=39 N(Parapodium)=26 N(RGO)=13 RGO – Reciprocating Gait Orthoses	**Population:** (Parapodium) Age (at injury)=3.2yr. (range birth-9yr.); Gender: males=15, females=11; Level and severity of injury: T1-T4 paraplegia=7, Tetraplegia=6, Not reported=13; Time since injury: Not reported. (RGO) Age at injury= 8.1yr. (range birth-15yr.); Gender: males=5, females=8; Level and severity of injury: T4 paraplegia=1, Tetraplegia=0, Not reported=12; Time since injury: Not reported. **Intervention:** Chart review of parapodium and RGO users. **Outcome Measures:** Post-orthotic use outcomes.	1. No patients in either group were community ambulators 2. Among the 20 children that began using parapodia at less than 6yr., 12 were household ambulators 3. All 6 children who began using parapodia after 6yr. old were therapeutic ambulators 4. Among children that initially used RGOs, 2 were household ambulators and the remaining 11 were all therapeutic ambulators 5. Of the 26 children in the parapodium group, four were lost to follow-up or died after a mean of 3.7 yr. of orthotic use, 12 continued to use their parapodia with a mean follow-up of 3.4 yr., and 10 stopped using their parapodia after 2.2 vr. on average 6. 12 children who continued to use their parapodium. the mean age at injury was 2 1/2 yr., mean age at initiation of parapodium use was 3.7 yr., and their mean age at current follow-up was 7.1 yr. 7. For the 10 children who had discontinued use of their parapodium, the mean age at injury was 5 yr., mean age at initiation of orthotic use was 5.7 yr., and mean age at discontinuation of parapodium use was 7.9 yr. 8. Among the 13 children who initiated their orthotic use with RGOS, three were lost to follow-up after using their RGOs for an average of 2 1/2 yr., two are still using RGOs and 8 have stopped using them 9. The two children still using them were approximately 2 1/2 yr. old when injured and began orthotic

			use at three and 3 1/2 yr. of age, each has been followed for 1 1/2 yr. 10. The eight individuals who discontinued RGO use were on average 10.8 yr. old at the time of their injury, began using the RGO at a mean age of 12 1/2 yr. and stopped using their RGOs at a mean age of 16.7 yr. 11. Of the eight individuals who discontinued RGO use seven did not progress to another orthotic device and one teenager with T10 paraplegia progressed to a knee ankle foot orthosis (KAFO) which she used sporadically for 1 1/2 yr.
Time to complete task, WeeFIM	(Johnston et al., 2003) USA Pre-Post N=9	**Population:** Age: 12.7±5.2 yr (range 7-20 yr); Level and Severity of Injury: C7 tetraplegia (n=1), T1-11 paraplegia (n=8); Long Leg Bracing [LLB] Used: Knee Ankle Foot Orthoses [KAFO] (n=2), Hip Knee Ankle Foot Orthoses [HKAFO] (n=2), Reciprocating Gait Orthoses [RGO] (n=5). **Intervention:** Lower extremity Functional Electrical Stimulation (FES) implant which delivered a balanced asymmetrical biphasic waveform with pulse duration up to 200 msec, 20 Hz frequency, and 20 mA current. Bilateral ankle foot orthoses (AFO) set in zero degrees of dorsiflexion were worn when ambulating with the FES system. After implantation and immobilization participants did 2-4 wk of FES strengthening followed by standing and walking exercise, and upright mobility training. **Outcomes:** Completion of eight upright mobility activities, scored based on completion time and level of independence: donning, stand and reach, high transfer, bathroom, floor to stand, 6-meter walk test (6MWT), stair ascent, stair descent.	1. Two subjects did not complete training and were not included for analysis. 2. 12/72 originally implanted electrodes required revision primarily due to inadequate force production. 3. Subjects completed four activities more quickly when using FES as compared to LLB: donning (p=0.0026), stand and reach (p=0.0012), high transfer (p=0.0009), bathroom (p=0.0164). 4. Subjects completed five activities with less assistance when using FES as compared to LLB: donning (p=0.0001), stand and reach (p=0.0036), high transfer (p=0.0191), bathroom (p=0.0006), and floor to stand (p=0243). 5. No activity required more time or more assistance to complete with FES as compared to LLB. 6. Subjects reported preferring FES for 87.5% of the activities, LLB for 3.6% of the activities, and showed no preference for 8.9% of the activities.
Time to complete task, TUG	(Johnston et al., 2005) USA Post Test N=3	**Population:** Age: 17-21; Gender: males=3; Level and Severity of Injury: Motor complete T3-T8; Time since injury: 1.0-1.5 yr; **Intervention:** Functional electrical stimulation (FES) consisting of 22-channel implant stimulator, extension leads and epineural electrodes. Leads emanating from the stimulator include two tresses of nine leads each for stimulation of lower extremity muscles and one tress of four leads for stimulation for bladder and bowel function (parameters: 0.2–8 mA amplitude, 25–600 ms pulse duration, 2–500 Hz pulse frequency per channel). After implantation and immobilization participants	1. Three of the 52 electrodes placed for lower extremity stimulation experienced changes in the responses of the muscles. 2. Two subjects used a walker with wheels to perform the mobility activities and one subject used forearm crutches 3. None of the subjects required physical assistance to complete the activities but two required supervision. 4. One individual could not ascend/descend stairs as it was felt to be unsafe for him; several activities could not be performed by another subject secondary to complaints of shoulder pain

		completed exercise phase (FES strengthening) followed by lower extremity conditioning, standing and upright mobility training (13 wk). **Outcome Measures:** Completion of eight upright mobility activities, scored based on completion time and level of independence: donning, stand and reach, high transfer, bathroom, floor to stand, 6-meter walk test (6, stair ascent, stair descent;	related to poor scapular muscle control. 5. All subjects reported preferring a swing through pattern for walking as they felt it was faster; two subjects could ambulate up to 20 feet and the third subject up to 75 feet 6. Just one subject demonstrated positive neuromodulation effects of the bladder; stimulation suppressed reflex bladder contractions acutely thereby reducing vesical pressure 7. For one subject, low frequency stimulation significantly increased rectal and anal sphincter pressure which reduced time to defecate; compared to bowel management without stimulation, the patient reported greater satisfaction with stimulation.
WeeFIM, WISCI II	(Prosser, 2007) USA Case Report N=1	**Population:** 5 yr.10 mo, female, C4 AIS A SCI and mild traumatic brain injury. **Intervention:** Locomotor training including body weight support treadmill training, overground walking, inpatient rehabilitation with aquatic therapy. **Outcome Measures:** Functional Independence Measure for Children II (WeeFIMII), Walking Index for Spinal Cord Injury II (WISCI II).	1. WeeFIM score improved from 5/35 to 21/35 over 5 months of locomotor training 2. WISCI score improved from 0 to 12 over 5 months of locomotor training 3. At home, she walked the majority of the time and walked up the stairs to her bedroom with a handrail and minimal assistance
WISCI II	(Fox et al., 2010) USA Case Report N=1	**Population:** 3.5 yr, male, C8 AIS C SCI. **Intervention:** Description of child's walking function and musculoskeletal growth and development during the 2 yr after locomotor training **Outcome Measures:** Walking Index for Spinal Cord Injury II (WISCI II), gait speed, cadence, step length, stride length, daily steps activity at home and in the community, musculoskeletal growth and development, gross motor function measure (GMFM-66).	1. Walking independence remained unchanged with WISCI score staying at 13/20 as he still used a reverse rolling walker to ambulate 2. Fastest gait speed increased from 0.45m/s at baseline (1 month post LT) to 0.67m/s at 2 yr. follow-up • After 2 yr., gait pattern was improved • Able to generate reciprocal stepping with noticeable absence of shoulder and trunk compensations, particularly on his left side • Despite being able to step reciprocally, he could not walk backwards, side step, or maintain balance without upper-extremity support 3. Cadence increased from 63.35 steps/min at baseline to 70.75 steps/min at 2 yr follow-up 4. Step length increased in both legs: • Left leg: increased from 42.25 cm at baseline to 51.31 cm at 2 yr follow-up • Right leg: increased from 44.07 cm at baseline to 63.55 cm at 2 yr follow-up

			5. Stride length increased in both legs: • Left leg: increased from 85.95cm at baseline to 114.79cm at 2 yr follow-up • Right leg: increased from 87.19cm at baseline to 114.47cm at 2 yr follow-up 6. Daily steps increased from about 1600 steps/day at baseline to 3000 steps/day at 2 yr follow-up 7. Over the 2-yr. period the child was not diagnosed with scoliosis, but mild coxa valga was noted at both hip joints and radiology reports indicated all findings stable 8. GMFM-66 scores remained stable over the 2-yr period