| Author, Year<br>Country<br>Study Design<br>Sample Size | Population<br>Intervention<br>Outcome Measure | Results |
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| (Canon et al., 2015)<br>USA<br>Observational<br>N=13 | **Population:** Mean age: 12.4 yr; Gender: males=5, females=8; Injury etiology: cervical SCI=6, thoracic SCI=3, transverse myelitis=2, encephalomyelitis=2.<br>**Intervention:** None. Urodynamic study (UDS).<br>**Outcome Measures:** Autonomic dysreflexia (systolic blood pressure 15-20 mmHg above baseline and/or presence of associated symptoms. | 1. In total, 41 UDS were performed, with an average of 3.2 studies per patient.<br>2. Among 13 subjects, 1 adolescent (C1/2 level injury) and 1 prepubertal child (T2/3 level injury) experienced AD; both patients experienced AD initially and on subsequent UDS, with one having a total of seven episodes of AD.<br>3. Symptoms of AD for one subject included blood pressure elevation, facial flushing.<br>4. Symptoms of AD and hypertension were resolved in both subjects with bladder drainage alone, without any need for pharmacological intervention; no major complications were observed.<br>5. There did not appear to be noticeable correlations of AD with gender, actual-to-estimated bladder ratio, presence of uninhibited detrusor contractions, bladder compliance, presence of bacteria during UDS, or those with transverse myelitis or encephalomyelitis. |
| (Hwang et al., 2014a)<br>USA<br>Observational<br>N=351 | **Population:** *Pediatric-onset SCI*: Mean age at injury: 13.8 (0-18) yr; Mean age at interview: 26.7 yr; Gender: males=226, females=125; Time since injury: 12.9 yr; Level of injury: C1-4 AIS ABC=52, C5-8 AIS ABC=126, T1-S5 AIS ABC=136, AIS D=34, unknown=3.<br>**Intervention:** None. Survey.<br>**Outcome Measures:** Incidence and prevalence of medical complications (pressure ulcers [PU], autonomic dysreflexia [AD], spasticity). | 1. In total, 1793 interviews were conducted.<br>2. The prevalence of PU, AD, and spasticity were higher in those with more rostral neurologic level of injury, whereas the prevalence of most complications were lower in the AIS D group compared to the other impairment groups.<br>3. At first interview, the prevalence of hypertension/cardiac disease was similar among the injury severity groups (2.0–2.9%), as was the prevalence of shoulder pain (38–50%).<br>4. Over a median interval of 5.1 yr between the first and last interviews in all our participants (n=351), the prevalence of bladder accidents, hypertension/cardiac disease, and activity limiting upper extremity joint pain showed a tendency to increase.<br>5. The prevalence of PUs, urolithiasis and bone fractures showed a pattern of decrease, while no patterns of change in prevalence was noted for UTI, AD, spasticity, pneumonia/respiratory failure, and bowel accidents between the two time points.<br>6. Odds of complication occurrence over time varied among severity groups, with increased ORs in the C1-4 ABC group of:<br>• severe urinary tract infection (1.05, CI 1.02–1.09);<br>• AD (1.09, CI 1.05–1.14);<br>• spasticity (1.06, CI 1.01–1.11);<br>• pneumonia/respiratory failure (1.09, CI 1.03–1.16); and<br>• hypertension/cardiac disease (1.07, CI 1.01–1.15);<br>• Odds of complication occurrence over time varied among severity groups, with |

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| | | increased ORs in the C5–8 ABC group: AD (1.08, CI 1.04–1.13); and pneumonia/respiratory failure (1.09, CI 1.02–1.16).<br>• Odds of complication occurrence over time varied among severity groups, with increased ORs in the T1-S5 ABC group: hypertension/cardiac disease (1.08, CI 1.02–1.14).<br>7. Upper extremity joint pain had increased odds of occurrence in all injury severity groups. |
| (Hwang et al., 2014b)<br>USA<br>Observational<br>N=283 | **Population:** *Pediatric-onset SCI:* Age at interview: 27.3±3.7 (21-37) yr; Age at injury: 14.5±4.3 (0-18) yr; Gender: males=182, females=101; Time since injury: 12.7±5.0 (4-30) yr; Level of injury: tetraplegia=174; Severity of injury: complete=195; C1-4 AIS ABC=46, C5-8 AIS ABC=110, T1-S5 AIS ABC=99, AIS D=28.<br>**Intervention:** None. Annual interviews.<br>**Outcome Measures:** Satisfaction with Life Scale (SWLS), Short-Form 12 Health Survey (SF-12), Patient Health Questionnaire-9 (PHQ-9), and Craig Handicap Assessment and Recording Technique (CHART). | 1. Those attaining a bachelor's degree or higher had increased from 33.2% at the first interview to 47.0% at the last interview.<br>2. There was no change in the proportion of employed versus unemployed from the first (56.8% versus 43.2%) to last interview (58.1% versus 41.9%) (less than general population estimates).<br>3. At the last interview, the proportion of employed participants was significantly higher in those with a baccalaureate and post-baccalaureate degrees, whereas the proportion of unemployed individuals was higher in those with a high school diploma.<br>4. Women and married participants also had higher rates of employment at the last interview than men and single participants, respectively.<br>5. There was no significant change in employment status over time (OR 1.01, confidence interval (CI) 0.98-1.04).<br>6. Odds of employment increased over time in participants who were women (1.04, CI 1.00-1.08), married (1.05, CI 1.02-1.08), attained a baccalaureate degree (1.03, CI 1.00-1.07), or post-baccalaureate degree (1.05, CI 1.02-1.08).<br>7. Odds of employment decreased over time in participants with occurrence of autonomic dysreflexia (0.80, CI 0.65-0.99), spasticity (0.80, CI 0.59-0.99) or chronic medical condition (0.83, CI 0.71-0.98).<br>8. Life satisfaction (SWLS) scores increased over time in those who remained employed (1.11, CI 1.01-1.22).<br>9. Odds of depression (PHQ-9) increased over time in those who remained unemployed (1.13, CI 1.04-1.23). |

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| (Zebracki et al., 2013b)<br>USA<br>Observational<br>*Part I (n=279)* | **Population:** Age: 0-5 yr=30, 6-12 yr=93, 13-15 yr=52, 16-18 yr=104; Gender: males=160, females=119; Time since injury: 38.7±44.0 mo; Level and severity of injury: C1-4 AIS ABC=29, C5-8 ABC=56, T1-S5 ABC=175, D=19; complete=174, tetraplegia=94.<br>**Intervention:** None. Chart review.<br>**Outcome Measures:** Systolic and diastolic blood pressure, heart rate. | 1. There was a stepwise increase in baseline blood pressures and decrease in heart rates with increasing age (p<0.001).<br>2. Boys demonstrated higher systolic blood pressures (p<0.001) whereas girls had higher heart rates (p=0.02); this is similar to the difference observed in typically developing youths.<br>3. There was no difference in diastolic blood pressure between genders.<br>4. There was a significant diurnal difference in blood pressure and heart rate, with both elevated in the evening compared to morning values (p<0.001).<br>5. There was no significant difference in any measures between youth with tetraplegia and those with paraplegia.<br>6. A significant association was not found for duration of injury with any of the measures. |
| (Schottler et al., 2009)<br>USA<br>Observational<br>N=215 | **Population:** Age: 9.1 yr; Gender: males=127, females=88; Level of injury: tetraplegia=116, paraplegia=99; >T6=168, <T6=47; Severity of injury: complete=110, incomplete=105.<br>**Intervention:** None. Survey.<br>**Outcome Measures:** Patients and families were asked four yes/no questions: (1) Does the patient experience autonomic dysreflexia (AD)? (2) Does the patient/caregiver know what AD is? (3) Can the patient/caregiver name three signs/symptoms of an AD episode? (4) Does the patient/caregiver know how to treat AD? | *Does the patient experience AD?*<br>1. Overall, 40% of patients and 44% of caregivers said that the patient did experience or was symptomatic for AD.<br>2. Multiple logistic regression showed that children with injury levels ≥T6 (p<0.001) and those in the oldest age (14-21 yr; p<0.001) were more likely to say that they experienced AD.<br>3. Multiple logistic regression analysis showed that caregivers of people with injury levels ≥T6 (p=0.005) and those with a greater injury severity (AIS; p=0.014) were more likely to experience AD.<br><br>*Does the patient/caregiver know what AD is?*<br>4. There was no association between patients' ability to define AD with gender, race or AIS classification.<br>5. Patients who were able to define AD were more likely to have traumatic etiologies (p<0.001), have ≥T6 injuries (p=0.007), have a shorter duration of injury (p<0.001) and be in the oldest age at injury group (14-21 yr; p<0.001).<br>6. Caregivers of who were able to define AD were more likely to have patients with traumatic etiologies (p=0.007), have ≥T6 injuries (p=0.001), and be in the oldest age at injury group (14-21 yr; p<0.010).<br><br>*Can the patient/caregiver name three signs/symptoms of an AD episode?*<br>7. There was no association between a patient's ability to identify three signs/symptoms of AD with gender, race or AIS classification.<br>8. Patients with the ability to name three signs/symptoms of AD were more likely |

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| | | to have traumatic injuries (p=0.014), ≥T6 injuries (p=0.006), have a shorter duration of injury (p=0.030), and be in the oldest age at injury group (14-21 yr; p<0.001).<br>9. Caregivers with the ability to name three signs/symptoms of AD were more likely to have children with injuries ≥T6 (p=0.001) and who were older at interview (p=0.005).<br><br>*Does the patient/caregiver know how to treat AD?*<br>10. There was no association between a patient's knowledge of how to treat AD with gender, race or AIS.<br>11. Patients who were able to express how to treat AD were more likely to have traumatic etiologies (p=0.001), have ≥T6 injuries (p=0.003), have a shorter duration of injury (p=0.003) and be in the oldest age at injury group (14-21 yr; p<0.001).<br>12. Caregivers who were able to express how to treat AD were more likely to have children with traumatic etiologies (p=0.020), level of injury (p<0.001), age at injury (p=0.032) and age of patient at time at interview (p=0.008).<br>13. Of the patients with a positive history of AD, 15% did not know the definition of AD, 20% could not identify three signs/symptoms of AD and 6% said they did not know how to treat an AD episode if it were to occur.<br>14. For the caregivers of patients who experienced AD, 9% did not know the definition of AD, 20% could not identify three signs/symptoms and 9% said they did not know how to treat an AD episode. |
| (Liusuwan et al., 2007)<br>USA<br>Observational<br>N=215<br>(N=33 SCI) | **Population:** *SCI Group (n=33):* Age: 17.5±2.2 yr; Gender: males=21, females=12. *SB Group (n=66):* Age: 15.8±2.6 yr; Gender: males=36, females=30. *Able-Bodied Overweight (OW, n=31) Group:* Age: 15.6±2.6 yr; Gender: males=12, females=19. *Able-Bodied Control (CTRL, n=85) Group (n=60):* Age: 15.9±2.4 yr; Gender: males=44, females=16.<br>**Intervention:** None. Anthropometric testing.<br>**Outcome Measures:** Height, weight, Bone Mineral Content (BMC), Fat Tissue Mass (FTM), Total Lean Tissue Mass (TLM), Total Body Fat, Resting Energy Expenditure (REE). | 1. There was no significant difference in height between the CTRL and OW groups, but the SB group was significantly shorter (p<0.05).<br>2. The OW group weighed significantly more than the SB, SCI, and CTRL groups(p<0.05).<br>3. The OW group BMI was significantly higher than that of the SB group, which in turn was significantly higher than those of both the CTRL group and SCI group (p<0.05).<br>4. BMI was not significantly different between CTRL and SCI groups (p<0.05).<br>5. SB subjects had the lowest TLM compared to the CTRL and OW groups (p<0.05), but there was no significant difference in TLM between SB and SCI.<br>6. Although the OW group had significantly higher fat mass than all other groups, there was no significant difference between the percent fat of OW versus SB group.<br>7. When REE was adjusted for kg of TLM, there were no differences in REE/TLM |

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| | | ratio among the CTRL, OW, and SCI groups; SB had significantly higher REE/TLM ratios as compared to the REE/TLM ratios in the CTRL, OW, and SCI groups. |
| (Hickey et al., 2004)<br>USA<br>Observational<br>N=121 | **Population:** Age: 6 yr (0-13 yr), divided into three age groups: 0-5 yr, 6-13 yr, 14-21 yr.<br>**Intervention:** None. Chart Review.<br>**Outcome Measures:** Episodes of autonomic dysreflexia (AD). | 1. Among 121 subjects, 62 (51%) experienced AD.<br>2. A total of 27 AD episodes were experienced while during hospitalization and 163 episodes during an outpatient visit for which there were no significant differences in causative factors or symptoms between settings.<br>3. The most common causes of AD were urologic complications (75%), primarily bladder distension (89%), and bowel impaction (18%).<br>4. For episodes of AD that occurred in all three age ranges, the most common symptoms were facial flushing (43%), headache (24%), sweating (15%), and piloerection (14%).<br>5. In contrast to the two older age groups, the youngest age group experienced headaches (p=0.047) and piloerection (p=0.046) uncommonly and facial flushing more commonly (p=0.016).<br>6. Of the 62 affected participants, 27 AD episodes were observed in 18 individuals<br>• 2 episodes occurred in children <5 yr, 19 occurred among those 6-13 yr and 6 in those 14-21 yr;<br>• mean increases in systolic and diastolic blood pressure was 45 mm Hg and 30 mm Hg;<br>• heart rate was evaluated in just 16 episodes for which it was within 10% of baseline values for 6 episodes, bradycardic for 2 episodes (>20% below baseline), and tachycardic for 8 episodes (>20% above baseline).<br>• Pharmacological management was not required for any of the observed episodes, and there were no observed or reported complications of AD.<br>7. AD episodes were greater among those with:<br>• complete tetraplegia compared to complete paraplegia (p=0.047);<br>• traumatic SCI compared to medical or surgical causes (p=0.018; 6-13 yr age bracket only);<br>• those injured at an older age (6-21 yr) compared to those injured younger (<5 yr; p=0.014);<br>8. Regression analysis showed that AD was significantly associated with completeness of injury (complete versus incomplete) and older age at injury (6-13 yr versus <5 yr). |
| (Vogel et al., 2002b)<br>*Part I*<br>USA<br>Observational<br>N=216 | **Population:** Age at injury: 14.1±4.0 yr; Age at interview: 28.6±3.4 yr; Gender: males=150, females=66; Time since injury: 14.2±4.6 yr; Level of injury: tetraplegia=123, paraplegia=93. Severity | **Analyses of AD were limited to individuals with C1 to T61evels of injury:<br>1. Within this group, 54% experienced AD; of 85 individuals, 74 had tetraplegia, and 11 had paraplegia. |

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| | of injury: C1-4 ABC=41, C5-8 ABC=67, T1-S5 ABC=82, tetra/para D=26.<br>**Intervention:** None. Survey.<br>**Outcome Measures:** Prevalence of urinary tract infections (UTI), pressure ulcers, hemorrhoids and rectal bleeding, hospitalizations, urinary stones, orchitis or epididymitis, pneumonia, need for ventilatory assistance, thromboembolism, and latex allergy, bladder and bowel incontinence, length of bowel program, constipation or diarrhea, dysreflexia, hyperhidrosis frequency of smoking cigarettes or marijuana, drinking alcohol. | 2. AD affected 62% of the subjects with tetraplegia and 30% of those with T1 to T6 paraplegia.<br>3. Of the individuals with T6 or higher SCI, who did not report AD, 24% had an ASIA Impairment Scale score of D; in contrast, none with T6 or higher lesions, who experienced AD, had ASIA Impairment scores of D ($p<0.001$).<br>4. Those with AD had significantly lower ASIA Motor scores compared with those who did not experience AD ($p<0.001$).<br>5. A total of 31 subjects experienced hyperhidrosis (22 had tetraplegia and 9 had paraplegia).<br>6. Of the 9 subjects with paraplegia and hyperhidrosis, 5 had T1 -T6 lesions and 4 had lower thoracic lesions.<br>7. Individuals with hyperhidrosis had significantly lower ASIA Motor scores ($p=0.007$).<br>8. Subjects who reported having hyperhidrosis were significantly more likely to experience AD compared with those who did not have hyperhidrosis $p<0.001$).<br>9. Among those with C1 to T6 SCI, those who experienced hyperhidrosis were more likely to experience AD compared with those who did not experience hyperhidrosis ($p=0.002$). |
| (Vaidyanathan et al., 1998)<br>United Kingdom<br>Case Series<br>N=24<br>(N=3 pediatric patients)<br>(N=11 pediatric-onset SCI patients) | **Population:** *Children with SCI (n=3):*<br>*Case CS:* 3 yr male, C1-2 tetraplegia;<br>*Case SM:* 2 yr, male, ventilator-dependent tetraplegia;<br>*Case NB:* 3 yr male, ventilator-dependent tetraplegia;<br><br>*Adults with pediatric-onset SCI (n=11)*<br>*Case WC:* 32 yr female with SCI at 14 yr, C4 tetraplegia.<br>*Case MH:* 32 yr male with SCI at 21 yr, C5 tetraplegia.<br>*Case KW:* 44 yr male with SCI at 15 yr, C4 tetraplegia.<br>*Case DM:* 22 yr male with SCI at 17 yr, C6 tetraplegia.<br>*Case GE:* 30 yr male with SCI at 17 yr, C5 tetraplegia.<br>*Case SB:* 29 yr male with SCI at 17 yr, C5 tetraplegia.<br>*Case AM:* 33 yr male with SCI at 14 yr, T4 paraplegia.<br>*Case OL:* 29 yr male with SCI at 19 yr, C3 tetraplegia.<br>*Case AG:* 30 yr male with SCI at 17 yr, C5 tetraplegia.<br>*Case DB:* 16 yr male with SCI at 15 yr, C4 tetraplegia.<br>*Case PD:* 27 yr male with SCI at 19 yr, C4 tetraplegia.<br>**Intervention:** 1 mg (adults) or 0.5 mg (children) terazosin titrated up to a maximum dose, if appropriate (i.e., 10 mg in adults and 2 mg in children). | *Children (n=3):*<br>1. Case CS required a maximum dose of terazosin 2 mg + oxybutynin 5 mg + 2.5 mg + 5mg and had nil side affects.<br>2. Case SM required a maximum dose of terazosin 1 mg + oxybutynin 2.5 mg 2x/day and had nil side affects.<br>3. Case NB required a maximum dose of terazosin 1 mg + oxybutynin 2 mg 4x/day and had nil side affects.<br><br>*Adults with pediatric-onset SCI (n=11)*<br>4. Case WC required a maximum dose of 3 mg + oxybutynin 5 mg and experienced nil side affects.<br>5. Case MH required a maximum dose of 5 mg and experienced nil side affects.<br>6. Case KW required a maximum dose of 6 mg and experienced nil side affects.<br>7. Case DM required a maximum dose of 5 mg and experienced nil side affects.<br>8. Case GE required a maximum dose of 2 mg and experienced nil side affects.<br>9. Case SC required a maximum dose of terazosin 5 mg and had nil side affects.<br>10. Case AM required a maximum dose of terazosin 3 mg and had nil side affects.<br>11. Case OL required a maximum dose of terazosin 1 mg and had nil side affects.<br>12. Case AG required a maximum dose of terazosin 4 mg and had nil side affects.<br>13. Case AG required a maximum dose of terazosin 2 mg and had nil side affects.<br>14. Case PD required a maximum dose of terazosin 2 mg and had nil side affects. |

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| | **Outcome Measures:** Abatement of autonomic dysreflexia and side effects. | |