Author Year; Country Score Research Design Total Sample Size	Methods	Outcome
[Pavese et al. 2019](#) Europe Longitudinal Level 2 N=1250	**Objectives:** To derive and validate a model for predicting the achievement of independent bowel management, with reliable bowel movements and continence, at 1 year after traumatic SCI **Population:** N: Derivation: 1250 Validation: 186 Level (D/V grp): C1-C8: 617/88 T1-T12: 451/60 L1-L5: 147/19 S1-S5: 2/15 AIS A: 556/60 AIS B: 140/17 AIS C: 192/37 AIS D: 341/54 AIS E: 3/0 Etiology: Traumatic Age: 42.5 (17.6)/ 44.3 (18.3) Female: 20.3%/16.1% **Treatment:** N/A **Outcome Measures:** Independent bowel management with regular bowel movements and appropriate timing. ISNCSCI, SCIM II and III scores.	1. The first predictor identified was the ISNCSCI total motor score. The aROC of the simplified model, based on this single predictor, was 0.837 (95% CI: 0.815-0.859). A sensitivity analysis found the aROC was 0.820 (95% CI: 0.768 to 0.883). 2. The second predictor was item 3a in SCIMs II and III. The addition of this second predictor to the first predictor conferred a small, but significant (P=.0035) increase in the predictive performance of the derivation cohort (aROC=0.848; 95% CI: 0.827-0.870). 3. The validation cohort confirmed that both models had very high predictive powers. The aROC of the model based only on the total motor score was 0.817 (95% CI: 0.754-0.881); the aROC of the model based on the 2 predictors—that is, the ISNCSCI total motor score and item 3a of the SCIM—was 0.836 (95% CI: 0.775-0.896). The addition of item 3a of the SCIM in the validation cohort did not significantly improve the model (P=.2315). 4. Derivation group, at initial assessment 13.4% patients exhibited independent, efficient bowel management. Of these, 91.6% showed unchanged bowel

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		management at 1-year follow-up. One year after SCI all 1250 participants showed independent, efficient bowel management.
[Lynch et al. 2000](#) New Zealand Case-control Level 3 N=1135 (467 SCI)	**Objectives:** Describe the bowel function of SCI patients and compare this with a general community control group. **Population:** N=467 SCI, 668 control (CON) (47% response rate) Mean Age (range): SCI: 43.5 (15-89) CON: 45.3 (17-78) Median Time since Injury (IQR): + Female: SCI/CON (83/83) Study Duration: **Treatment:** N/A **Outcome Measures:** 1. Bowel function 2. Incidence of incontinence 3. Methods of defecation 4. QoL	1. 92.3% of CON were never affected by incontinence, compared with 43.9% SCI patients (P<0.0001). 8.1% of SCI patients always have their everyday lives affected by incontinence, compared with 0.4% of controls. 2. SCI patients with complete injuries were more likely to have incontinence affect their lives (11.5% always affected) than those with incomplete injuries (4.7% always affected). 3. SCI patients with higher injuries, either complete (P<0.0001) or incomplete (P=0.0002) required assistance more frequently than other SCI patients. 4. 82.3% of those with complete high injuries required assistance, compared with 14.3% of those with complete lumbosacral lesions. 5. Fecal incontinence was also higher for people with complete SCI vs. incomplete SCI. 6. Incontinence affected quality of life for 62% of SCI patients, compared with 8% of controls.

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Attabib et al. 2021 Canada Retrospective Analysis Level 3 N=214	**Objectives:** To examine factors associated with improvement in lower-extremity motor scores (LEMSs), as well as recovery in ability to walk and bowel and bladder function after TCEI (Traumatic cauda equina injury) **Population:** N=214 total, 92 had bowel/bladder data available Level: L1, L2, L3-S3 AIS A: 48 AIS B: 30 AIS C: 39 AIS D: 90 Etiology: Fall (n=102), Transport (58), sports (30), other (19) Mean Age at injury (SD): 39.9 +- 17.3 Median Time since Injury to surgery (IQR): 26.5 (53.0) % Female: 50 (23%) **Treatment:** Examined factors associated with recovery in motor strength, walking ability, and bowel and bladder function to aid in prognosis and establishing rehabilitation goals. **Outcome Measures:** 1. Motor score 2. Recovery in walking 3. Recovery in Bowel and bladder function	1. Earlier rehab onset was the only significant predictor for more bowel improvement ($p = 0.005$), after adjusting for injury characteristics and time to surgery. 2. Voluntary anal contractions (VAC) at admission had significantly higher bowel scores. This resulted in smaller gains, as noticed by the change in bowel scores between VAC at admission and no VAC (VAC 1 vs VAC 5, p=0.0005). 3. Of the 87 patients with bowel dysfunction at rehabilitation admission, 24% had recovery (FIM = 7 on bowel subscore) at discharge. 4. Median change in both bowel and bladder score from admission to discharge was an increase of 4 points.
Khan et al. 2021 USA Case-control	**Objectives:** To predict independence in bowel function 1 year after SCI	1. The simplified logistic regression model, using only Total Motor Score

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Level 3 N=277	by evaluating the external validity of logistic regression models, developed on a multicenter European SCI (EMSCI) dataset, against a prospectively accrued North American SCI dataset. **Population:** N=277 patients derived from three prospective multicenter SCI studies based in North America. Level of injury: C1-C8: 198 (71.5%) T1-T12: 46 (16.6%) L1-L5: 12 (4.3%) S1-S5: 21 (7.6%) Severity of neurological deficit: AIS A: 80 (29.7%) AIS B: 32 (12.6%) AIS C: 34 (12.6%) AIS D: 110 (40.9%) AIS E: 11 (4.1%) **Treatment:** N/A **Outcome Measures:** The primary outcome measure of this study was independence in bowel function as defined by regular bowel movements requiring no assistance and fewer than 2 episodes per month of bowel incontinence. From the NACTN, STASCIS, and NASCIS III datasets, patients were included with functional data at baseline and 1-year post-injury, as assessed using the Spinal Cord Independence	(UEMS + LEMS from ISNCSCI) had a positive predictive value of bowel independence at 1-year post-SCI of 89.3%, and a negative predictive value of 74.0% (aROC of 0.869 (95% confidence interval: [0.826,0.911]) with an accuracy of 81.2%, a sensitivity of 75.5%, and a specificity of 88.5%. 2. The full logistic regression model, using Total Motor Score and SCIM 3a (independence in upper body dressing) had a positive predictive value of bowel independence at 1-year post-SCI of 84.8%, and a negative predictive value of 72.7%. The full model demonstrated an aROC of 0.864 (95% confidence interval: [0.822,0.906]) with an accuracy of 78.7%, a sensitivity of 75.5%, and a specificity of 82.8%. 3. The calibration curve of the full model had a slope of 0.93 and an intercept of −0.46, while the the calibration curve of the simplified model demonstrated a slope of 1.13 with an intercept of 0.03, and unlike the calibration plot for the full model, displayed good calibration

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	Measure (SCIM) and the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI). Two logistic regression models developed by the EMSCI group from [Pavese et al. (2019)](#) – simplified (total motor score UEMS and LEMS from ISNCSCI) and full (total motor score plus SCIM 3a – independence in upper body dressing). External validation was evaluated for both models by assessing their discrimination, calibration, and clinical utility. Discrimination and calibration were assessed using ROC curves and calibration curves, respectively, while clinical utility was assessed using decision curve.	across the full range of observed probabilities). 4. The difference in the calibration curve scores indicates that both the simplified model (using Total Motor Score as the only predictor) and the full model (using Total Motor Score and the SCIM Upper Body Dressing score) at good at predicting who will have bowel function independence at 1-year post-SCI. 5. However, the simplified model is better at predicting those above the probability threshold. In other words, for people who are more likely to achieve independence in bowel function (i.e., at larger observed probabilities, the full model tended to overestimate the chances of complete independence in bowel function).
[Squair et al. 2019](#) Canada Survey Level 5 N=47,868	**Objectives:** To estimate the prevalence of bladder and gastrointestinal dysfunction in the SCI population, to compare their odds with the non-SCI population and to assess the relationship of lesion level and severity on the odds for	1. SCI was associated with increased odds of bowel disorders (aOR = 2.3, CI: 1.5–3.4), as well as gastric ulcers (aOR: 3.3, CI: 2.1–4.8), even after adjusting for key confounding variables.

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	experiencing bladder and GI dysfunction. **Population:** study used Population-level data from the Canadian Community Health Survey (CCHS) and the SCI Community Survey. N=47,868 Female: 50.3% Median age: 55 to 59 y **Treatment:** N/A **Outcome Measures:** Spinal Cord Injury Community Survey: Bowel dysfunction items were: "In the past 12 months have you experienced this problem–Constipation?"; and "In the past 12 months have you experienced this problem–Bowel incontinence?" Each outcome was scored on a 0 to 5 scale ranging from "Never" to "Every day".	2. Complete SCI was associated with increased odds of bowel incontinence (aOR=2.1, CI: 1.7–2.6).
Dietz et al. 2021 USA Retrospective Observational Level 5 N=11,131	**Objective:** To understand the changes in bowel management needs over time following SCI **Population:** N=17,492 with known bowel management N=11,131 included those who had at least 1 follow-up visit at 5, 10, 15, 20 and 25 years post discharge Age: 45.5% 15-19 yrs 28% 30-44 yrs 17.8% 45-59 yrs 8.8% 60+ yrs	1. At the time of discharge from inpatient rehabilitation, the majority of individuals required total assistance (38.8%), whereas those with complete independence with bowel care represented a minority of the sample (10%). Participants in the total assistance category predominantly sustained an injury at the cervical spinal cord level ($p < .0001$).

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	<u>Level</u> 48% Cervical 36% thoracic 10% lumbar 0.3% sacrum 0% normal 5.7% unknown <u>AIS:</u> 45.7% A 12.2% B 14.5% C 24.1% D 0% E 3.5% Unknown 47.5% paraplegia 49.5% tetraplegia 0% normal 3% unknown Female: 20.7% **Treatment:** N/A **Outcome Measures:** Degree of independence with bowel management from discharge and across time	2. At 5 years, the majority of participants' functional bowel management classification had shifted to modified independence (34.7%) ($p<.0001$). Prevalence of modified independence classification remained statistically comparable at 10 ($p=.9797$), 15 ($p=.6730$), 20 ($p=.2216$), and 25 ($p=.0975$) years after discharge. 3. Shift in bowel management was more likely to occur within the first 5 years after SCI ($p<0.0001$). After 25 years, the distribution in those groups was statistically comparable to the 5-year distribution ($p>.05$). 4. The largest shift in bowel management occurred in participants who required minimal contact assistance (most classified as AIS A and paraplegia, toward a less dependent bowel management strategy that persisted throughout the 25-year follow up).
Stoffel et al. 2021 USA Cross sectional	**Objective:** To identify variables associated with severe bowel	1. Severe bowel symptoms were reported in 570 (42%) On multivariable logistic

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Level 5 N=1,373	symptoms in spinal cord injured people. **Population:** Age: 44 (13) yrs Female: 40% ASIA: 26% A, 16% B, 11% C, 3% D, 0.3% E, 31% unknown Level of injury: 5% high cervical, 39% low cervical, 20% high thoracic, 27% low thoracic, 9% lumbar/sacral Years since injury: 14 (11) yrs **Treatment:** N/A **Outcome Measures:** Bowel symptoms were assessed by the Neurogenic Bowel Dysfunction (NBD) score and patients scoring ≥14 was categorized as having severe bowel symptoms. Autonomic dysreflexia (AD) severity was measured using a six-item questionnaire and reported as total AD score (0–24). Bladder management was categorized as: voiding, clean intermittent catheterization (CIC), surgery (augmentation/diversion) or indwelling catheter.	regression, every point increase of AD total score was associated with 5% increased odds of having more severe bowel symptoms [OR 1.05 95% CI 1.03–1.10]. 2. SCI people with indwelling catheters (OR=2.16, 95% CI 1.40–3.32) or reconstructive surgery (OR=1.79, 95% CI 1.08–3.32) were almost twice as likely to report more severe bowel symptoms than those performing CIC.
Jiang et al. 2019 North America Cohort Level 2 N=801	**Objective:** To assess the prevalence of adverse events after traumatic SCI and to evaluate the effects on long-term clinical outcome **Population:** N=801 Female: 22% Median age (IQR): 46 (29-59) years	1. In adjusted analysis accounting for age, injury severity and level, acute AEs were found to be an independent predictor for rectal sphincter function (OR, 7.86; 95% CI, 4.31–14.32) at 6 months postinjury. 2. There were 2,303 recorded acute AEs; the most prevalent AEs were: pneumonia (218

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	Etiology: 39.8% fall 37.5% motor vehicle accidents 6.1% other Severity: 37.6% AIS A 11.7% AIS B 14.7% AIS C 28.5% AIS D 7.5% AIS E Level: 70.9% cervical 22.3% thoracic 6.7% lumbar/sacral **Treatment:** N/A **Outcome Measures:** ISNCSCI examinations, Functional Independence Measure (FIM), Spinal Cord Independence Measure (SCIM) Version 2, and the Walking Index for SCI measures Adverse Events measured: Included multiple events as classified by system – Respiratory, Cardiac Arrhythmias, Infectious, Gastrointestinal, Renal, and Neuropsychiatric.	occurrences, 9.5% of all recorded AEs), respiratory failure (207; 9.0%), anemia (197; 8.6%), urinary tract infection (139; 6.0%), pleural effusion (92; 4.0%), bradycardia (93; 4.0%), depression (89; 3.9%), and sacral ulcers (72; 3.1%). 3. AIS score was a predictive factor of a higher incidence of secondary adverse events in multivariable analysis (p< 0.001; ORs vs. AIS D = AIS C 2.13 (1.40–3.24); AIS B 3.25 (2.18–4.85), AIS A 4.70 (3.52–6.27).
[Elmelund et al. 2019](#) Denmark Cross-sectional Level 5 N=684	**Objectives:** Investigate the prevalence of, and conditions associated with, fecal incontinence in women with SCI. **Population:** N=684 Level: AIS A: 32 AIS B: 18	1. Of 436 women, 21% presented with normal bowel function, 79% had some neurogenic bowel dysfunction. 433 received treatment with chemical stimulants, oral laxatives, or surgical treatment. 2. Of 599 women, 210 had experienced fecal incontinence (FI) within the last 3 months, 125

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	AIS C: 50 AIS D: 354 AIS E: 3 Cervical: 224 Thoracic: 173 Lumbar: 76 Sacral: 12 Etiology: Traumatic (sports, assault, transport, fall, other cause), nontraumatic (congenital, degenerative, benign tumor, malignant tumor, vascular, infection, other) Mean Age: 54.6 $\pm$ 19.8 % Female: 100% **Treatment:** N/A **Outcome Measures:** Bowel function, urinary bladder function, QOL, neurologic level/completeness/ etiology of injury, mobility status, and spousal relationship	(21%) experienced on average daily-to-monthly FI. 3. Digital evacuation/stimulation was associated with a higher risk of FI monthly (p=0.002), compared with no digital evacuation/stimulation. 4. >=3 defecations/day & chemical, medical, or surgical treatment was associated with higher risk of daily-to-weekly FI compared with less frequent defecation (p=0.0003). 5. Most prominent risk factor of FI was myelomeningocele compared with other etiologies (OR=5.17). 6. FI was significantly associated with permanent use of wheelchair compared with no walking aids (p<0.0001 and p=0.04), a more complete paraplegic injury compared with a less complete injury at any level, follow-up after injury <3 months (p<0.0001 and p=0.004) and increasing age (p=0.03).
[Pazzi et al. 2021](#) USA Cross-sectional Level 5 N=364	**Objectives:** To determine the goals of people with SCI who are considering experimental therapies – a) whether sociodemographic factors, injury-specific characteristics and concerns over adverse events influence those goals and/or participation in experimental therapies and	1. The most frequently cited functional goals were improvement in bowel and bladder function and elimination of dysreflexia (60.4%). 2. Most respondents (83.7%) had sought information about experimental therapies, and

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	clinical trials; and (b) whether people with SCI feel they have adequate information about experimental therapies and clinical trials. **Population:** N=364 Age: 15.2% 18-34 y 26.9% 35-49 y 56.2% 50-74 y 1.7% 75 or older y Level: 48.7% cervical 40.6% thoracic 10.7% lumbar/sacral Time since injury: 19.3% under 5 years 25.1% 5-10 years 33.9% 10-28 years 21.6% 30+ years Female: 36% **Treatment:** N/A **Outcome Measures:** Survey asking people with SCI sociodemographic questions, injury characteristics and their goals for function as well as perspectives on participating in clinical trials/experimental therapies.	just under half (47.8%) had received one. 3. Several goals were influenced by age and level and completeness of injury, and most respondents (93.4%) wanted more information about experimental therapies.
[Tate et al. 2016](#) North America Cross-sectional Level 5 N=291	**Objectives:** To assess the factors associated with methods of bowel management and bowel-related complications; and to determine the risk factors associated with bowel complications and overall	1. Increased likelihood of incontinence was associated with not having a colostomy or ileostomy (p<.05); not being married or having a significant other (p<.05); timing of one's bowel program to occur at a regular time (p=.005); being

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	bowel dysfunction. **Population:** N=291 Level (%): Incomplete paraplegia: 12.7 Complete paraplegia: 32.0 Incomplete tetraplegia: 26.1 Complete tetraplegia: 29.2 Etiology: Traumatic Age (mean): 50.7 +- 12.5 Time since injury (mean): 20 +- 10.5 yrs Female (%): 26.1 **Treatment:** N/A **Outcome Measures:** The Bowel and Bladder Treatment Index (BBTI), Fecal Incontinence Severity Index (FISI), Neurogenic Bowel Dysfunction Score (NBD) and self-report of constipation or incontinence, etc.	able to delay defecation ($p<.05$); presence of constipation ($p<.05$); higher NBD scores ($p<.0005$); increased frequency of urinary incontinence ($p<.05$); and higher consumption of diuretics ($p<.05$). 2. The model for constipation had a chi-square of 135.656 and Nagelkerke $R^2=.510$. Factors associated with being less likely to have constipation included younger age ($p=.05$); race/ethnicity ($p<.05$), with whites being less likely to have constipation than blacks ($p<.005$); incomplete tetraplegia versus complete tetraplegia ($p<.05$); having normal defecation ($p=.01$); and less frequent bowel movements ($p<.0005$). 3. Conversely, having a history of bowel surgery ($p<.05$); using laxatives, medications, or both, as a main method ($p<.0005$); receiving caregiver services ($p<.05$); and experiencing more frequent abdominal pain ($p<.005$) were all associated with constipation. 4. The model for bowel dysfunction has an F statistic of 9.590 and an adjusted $R^2=.265$ Having incomplete paraplegia ($p<.05$), complete paraplegia ($p<.01$), or incomplete tetraplegia ($p<.05$)

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		were all associated with less bowel dysfunction, as were whether participants used laxatives/oral medications as a main method of bowel management (p<.05), had higher fiber intake (p<.05), and lower scores on the FISI (p<.0005).
Liu et al. 2010 Taiwan Cross-sectional Level 5 N=232	**Objective:** To analyze the predictors of severe neurogenic bowel dysfunction (NBD) in persons with spinal cord injury (SCI). **Population:** N=232 (142/61% responded) Level: AIS 38 A, 34 B, 33 C, 37 D Etiology: vehicular accidents (42.9%), falls (28.2%), sports (6.3%) and violence (3.5%). others (19.1%) Age: Mean 45.2 years; Range 18 - 84 years Duration: 1–2 years - 42 3–5 years – 31 6–9 years - 23 >10 years - 46 % Female: 25.4 **Treatment:** N/A **Outcome Measures:** NBD score, Beck Depression Inventory, demographic factors, and injury-related factors	1. Multiple logistic regression analysis showed that those with a cervical injury (odds ratios (OR 10.5, 95% CI 1.6–67.7) or a thoracic injury (OR 7.1, 95% CI 1.2–40.3) had a higher risk of severe NBD than those with a lumbar injury. 2. People with American Spinal Injury Association Impairment Scale (AIS) A had a 12.8-fold higher risk of severe NBD than persons with AIS D (OR 12.8, 95% CI 3.3–50.1). 3. Longer duration of injury (>10 years) was another risk factor of severe NBD. 4. Moderate-to-severe depression was associated with reduced bowel function.
Adriaansen et al. 2015 Netherlands Cross-sectional	**Objectives:** Aim of the current study was to describe long-term bowel management and NBD in	1. Participants using surgical bowel management were significantly older (p=.008) and

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Level 5 N=258	individuals who have been living with an SCI for at least 10 years in The Netherlands **Population:** N=258 Level (%): AIS A: 70% AIS B: 12% AIS C: 9% AIS D: 9% Etiology: 90% traumatic Mean Age (range): 48 (29-65) Mean time since Injury (range): 24 (10-47) % Female: 27 (%) **Treatment:** N/A **Outcome Measures:** 1. Bowel management and bowel problems using international SCI bowel function data set 2. Constipation (Rome III criteria) 3. Bowel management (spinal cord independence measure) 4. Satisfaction 5. NBD score	had a significantly longer TSI (p=.002) than those using TAI. They also had longer TSI than those using a conservative bowel management method (p=.002). 2. 36% of the participants suffered from severe NBD. Participants with severe NBD decreased over time from 44% to 26%, and an increase in TSI was significantly correlated with a decrease in the total NBD score (p=.003). 3. Severe NBD was also positively associated with completeness of the lesion (p=.010) and was negatively associated with increasing age (p=.038). 4. Severe NBD as the dependent variable showed that completeness of the lesion (OR=1.98, p=.046), use of suppositories (OR=4.02, p<.001), and digital evacuation (OR=2.40, p=.003) were significant predictors of severe NBD. 5. Dissatisfaction with bowel management was associated with having perianal problems (p=.005), constipation (p=.001), and severe NBD (p<.001). 6. Satisfaction with bowel management as the dependent variable showed that constipation (OR=3.16, p=.003) and severe NBD (OR=3.53, p=.001) were

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		significant predictors of dissatisfaction with bowel management.