Paralyzed Veterans of America

consortium for SPINAL CORD MEDICINE
CLINICAL PRACTICE GUIDELINES

CLINICAL PRACTICE GUIDELINES: SPINAL CORD MEDICINE

Outcomes Following Traumatic Spinal Cord Injury

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Outcomes Following Traumatic Spinal Cord Injury

2nd edition

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These guidelines have been prepared based on scientific and professional information available in 2025. Users should periodically review this material to ensure that the advice herein is consistent with current reasonable clinical practice. The websites noted in this document were current at the time of publication; however, because web addresses and the information contained therein change frequently, the reader is encouraged to stay apprised of the most current information.

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Preface

This clinical practice guideline (CPG) is a second edition and represents a considerable revision from the original Outcomes Following Traumatic Spinal Cord Injury CPG published in 1999. During the intervening 27 years, the spinal cord injury literature has expanded considerably, as clinicians have fine-tuned the understanding of outcomes across a broad set of clinical and psychosocial domains. Furthermore, the literature has better established the multitude of care requirements necessary to optimize functional outcomes for individuals with spinal cord injury. In addition, newer pharmacologic, therapeutic, surgical and technological interventions have come along, considerably changing what can and should be offered those with SCI.

The CPG panel came up with 55 key questions related to outcomes after SCI from which key words were generated (provided in the Appendix). The English language medical literature was then searched and screened using a sliding scale of inclusion for relevant articles (described in the methods section). A grading of each recommendation on a four point scale and a strength of recommendation on a three point scale was then applied by the panel.

This CPG provides consensus recommendations from the multidisciplinary consensus panel in three broad areas: 1) Neurological Outcomes, 2) Functional Outcomes and 3) a new category entitled Outcome Modifiers. These areas are further divided into sections. The Neurological Outcomes area includes subsections on ASIA Impairment Scale (AIS) conversion, AIS conversion & sacral sparing, motor recovery and sensory recovery. The Functional Outcomes area consists of subsections on respiratory, bowel, bladder, sexual health, seated activities, wheeled mobility, walking, arm and hand function, transportation and driving, skin care, and community participation. The Outcome Modifiers portion includes subsections on societal attitudinal factors, environmental factors, spasticity, pain, bone density, health management behaviors & adherence, comorbid mental health conditions, body mass index & body habitus, physical inactivity, deconditioning & sedentariness, age, cognition, orthopedic polytrauma & upper limb pain, use of adaptive technology, socioeconomic status, influence of standard rehabilitation, and traumatic vs. nontraumatic SCI. Taken together, this group of recommendations is more comprehensive than any previous compilation in the field.

The strength of this CPG lies not just in its comprehensiveness, but also in the extensive discussion of rationales that back up these recommendations. These rationales include copious literature references and are summarized where appropriate in tables, especially in the Neurological Outcomes section. The need for inclusion of an extensive rationale component throughout this CPG is because these guidelines are based primarily on observational studies, as randomized controlled trials are hard to come by in this field.

On behalf of the consortium steering committee, I wish to acknowledge the chair of the guideline panel, Dr. Edelle Field-Fote for her leadership in this substantial opus. I acknowledge the panel itself, which consisted of a talented multidisciplinary group of experts in the SCI outcomes field. All of their effort is volunteer work. Furthermore, there were many reviewers who provided valuable feedback along the way. I also wish to acknowledge the ongoing support of the Paralyzed Veterans of America (PVA), including President Robert Thomas, Chief Executive Officer Carl Blake and Chief Operating Officer Shaun Castle. Thanks also to Lindsay Perlman, Director of Research and Education. Finally, I would like to remind the reader that the PVA is a nonprofit organization which relies heavily on philanthropic contributions in order to support its important work, including the ongoing development and revision of these guidelines.

Peter H. Gorman, MD, MS, FAAN, FASIA
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Foreword

People with spinal cord injury and their families face a profound and deeply personal set of concerns and questions in the aftermath of injury. These questions center on the extent of anticipated neurological recovery, the path toward functional independence, the specific equipment and assistance required for daily activities, and the prospects for a fulfilling life with meaningful social participation. For the rehabilitation team, addressing these questions is their professional mandate. For policy makers and case managers, the answers to these questions provide the essential evidence required to allocate resources and authorize the specialized care and technology that support autonomy.

The scope of outcomes after spinal cord injury is vast and complex. Accordingly, these guidelines reflect the diversity of topics it encompasses, and the volume of content is substantial. It is important to bear in mind that a considerable proportion of the data summarized comes from large databases derived from specialized clinical systems, and thus represent outcomes achieved in settings with comprehensive expertise and resources. Because the recommendations are grounded in evidence derived primarily from observational studies, the findings should be interpreted with the understanding that causal relationships cannot be definitively inferred. Rather, these recommendations represent the best available synthesis of current knowledge to guide practice in an area where high-quality experimental research is generally not feasible.

My sincere thanks to my colleagues who served on the guideline development panel. Their collective expertise, thoughtful dialogue, and steadfast commitment were essential to the development of these guidelines. I am deeply grateful for the considerable time they devoted to this effort and for their perseverance through the many challenges encountered along the way. The members of the panel are indebted to the Spinal Cord Injury Research Evidence team (https://scireproject.com/) for their methodological support. Their systematic searches, data extraction, and comprehensive evidence summaries were invaluable in enabling the panel to carry out its work efficiently and effectively.

On the whole, the evidence summarized in these guidelines demonstrates that across a wide spectrum of clinical profiles, people with spinal cord injury live long, productive, and fulfilling lives. Indisputably, the attainment of optimal outcomes is dependent on access to specialized healthcare, appropriate equipment, and necessary socioeconomic resources. These guidelines are intended to provide an evidence-based answer to the questions of what functional and psychosocial outcomes can be expected after spinal cord injury, drawing on extensive literature and the consensus of clinical experts. They provide evidence for the value of a person-centered approach, ensuring that care strategies remain relevant across every stage of life. For policy makers and third-party payers, this document highlights the link between specialized intervention and long-term outcomes.

Achieving optimal outcomes requires a structured evidence-informed approach. Effective clinical management must begin with a standardized neurological assessment to inform accurate prognosis and a personalized care plan. This plan must prioritize proactive respiratory protocols, neurogenic bowel and bladder management, and rigorous skin health strategies. In tandem, rehabilitation of the upper extremities is driven by the dual priorities of maximizing functional independence while equipping the individual with strategies to prevent overuse. Because mobility is essential for all aspects of life, depending on the individual's clinical profile, rehabilitation also focuses optimizing wheeled mobility and/or providing evidence-based locomotor training. Actively addressing secondary conditions such as spasticity, chronic pain, and bone density loss is essential to health and quality of life.

Enduring health and life satisfaction requires a shift beyond physical rehabilitation to include rigorous mental health screening, vocational support, and ensuring that care is equitable and responsive to key outcome modifiers such as age, socioeconomic status, and personal identity. Finally, it is the hope of this panel that by identifying critical gaps in current evidence base, particularly as relates to the need for sustainable strategies to strengthen caregiver support systems, we can foster more consistent achievement of the best possible outcomes. In doing so, we ensure that every individual with a spinal cord injury receives the support necessary to transform clinical potential into a meaningful, independent life.

Edelle (Edee) Field-Fote, PT, PhD
Panel Chair

Acknowledgments

Paralyzed Veterans of America (PVA) is proud to sponsor the development and dissemination of the spinal cord injury (SCI) clinical practice guidelines (CPGs). For over 30 years, we have partnered with the Consortium of Spinal Cord Medicine in a shared mission to improve the health of individuals living with SCI. Today, hundreds of thousands of copies of the guidelines are used around the world by physicians and other medical professionals who provide care to individuals living with SCI at every level, from the emergency department to acute care, rehabilitation to community services.

We thank Dr. Edelle Field-Fote for her leadership and perseverance in guiding this important updated guideline into practice. Sincere thanks are also extended to each of panel members who worked tirelessly, without remuneration, to bring this project to fruition. Dr. Peter Gorman and the members of the SCI Consortium have provided vision, leadership, and support in bringing this and many other CPGs to completion. Their efforts and those of the field reviewers assure the high quality of the recommendations.

As with any project of this magnitude, many were involved in the process. Sincere appreciation goes to Dr. Janice Eng and their team at SCIRE, who conducted the review of the literature and methodology for this guideline.

Within PVA, work on this guideline benefitted from the efforts of nearly every department, but special appreciation goes to medical editor Barbara Every and creative director Noel Abizo.

Finally, it is only with the significant mission-driven support of PVA, our leadership and our members, that we are able to provide these services. Sincere thanks to PVA President Robert Thomas, CEO Carl Blake, and COO Shaun Castle for their support.

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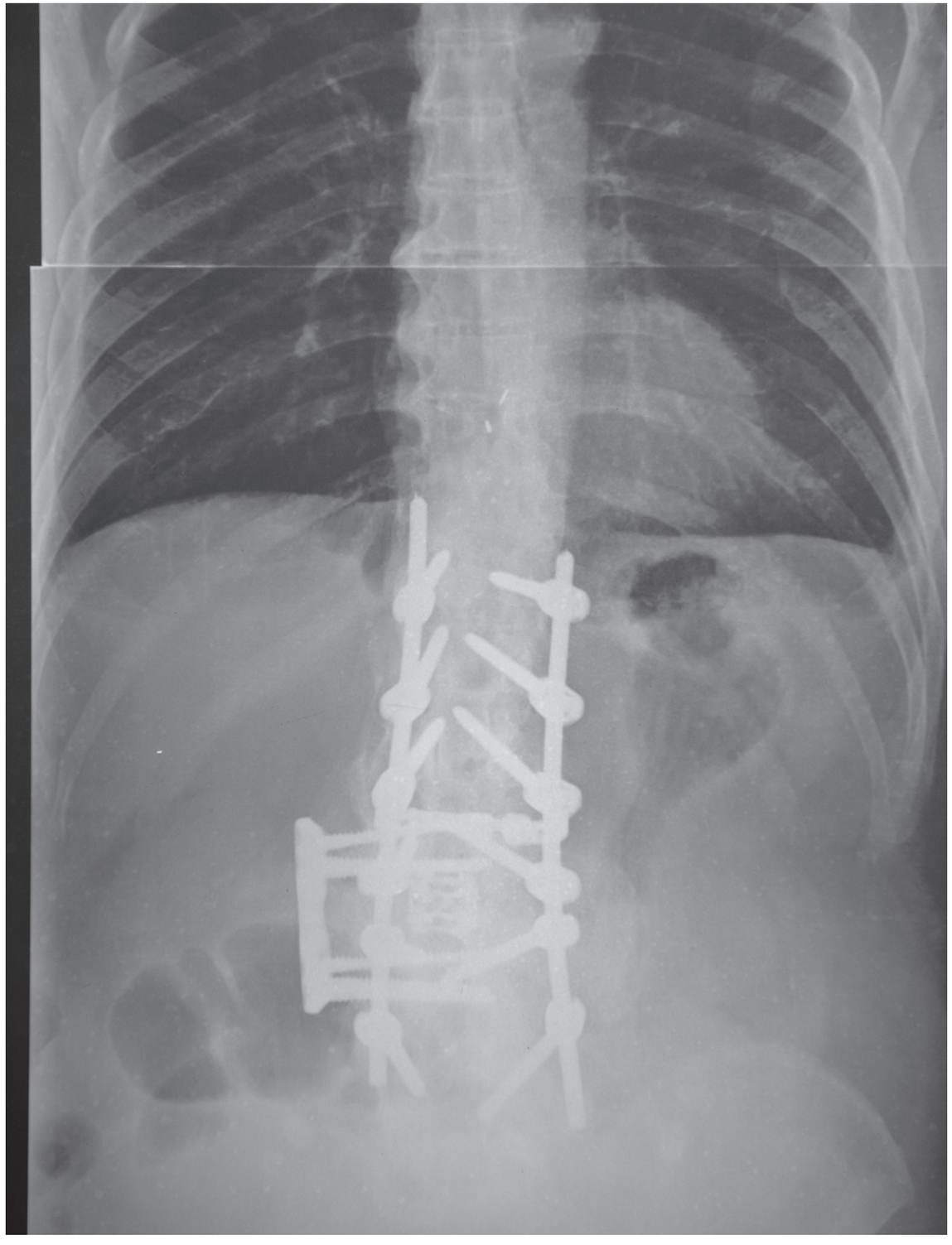

Abbreviations

ADA = Americans with Disabilities Act

AIS = American Spinal Injury Association Impairment Scale

ASIA = American Spinal Injury Association

BMD = bone mineral density

BMI = body mass index

CHART = Craig Handicap Assessment and Reporting Technique

CI = confidence interval

CPG = clinical practice guideline

DAP = deep anal pressure

eHealth = electronic health

FES = functional electrical stimulation

FEV1 = forced expiratory volume in 1 second

FIM = Functional Independence Measure

FVC = forced vital capacity

GRADE = Grading of Recommendations Assessment, Development and Evaluation

HR = hazard ratio

ISNCSCI = International Standards for the Neurological Classification of Spinal Cord Injury

LEMS = lower extremity motor score

LMN = lower motor neuron

LT = light touch

mHealth = mobile health

NBD = neurogenic bowel dysfunction

OR = odds ratio

PEF = peak expiratory force

PI = pressure injury

PP = pinprick

PTSD = post-traumatic stress disorder

PVS = penile vibratory stimulation

QOL = quality of life

RCT = randomized controlled trial

SCI = spinal cord injury

SCIRE = Spinal Cord Injury Research Evidence

SES = socioeconomic status

TBI = traumatic brain injury

UEMS = upper extremity motor score

UMN = upper motor neuron

UTI = urinary tract infection

WHO = World Health Organization

ZPP = zone of partial preservation

Introduction

Changes Since 1999 CPG

Increased emphasis on promoting restoration of function via use-dependent neuroplasticity
Advances in evidence related to use-dependent neuroplasticity have resulted in increased emphasis on practice and training as part of acute and subacute rehabilitation. This training focuses on restoration of typical movement rather than learning to use compensatory strategies. However, a dilemma exists in that rehabilitation lengths of stay are shorter than the time required to reach functional plateau. As a result, it is often necessary for individuals with spinal cord injury to learn compensatory strategies to enable them to function in the community after discharge from rehabilitation centers. These centers show great diversity in the emphasis placed on restoration vs. compensation, and studies have compared outcomes associated with these different approaches.

Executive Summary of Recommendations

1. Neurological Outcomes

1.1 We recommend that a thorough neurological examination be completed according to the International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) guidelines to determine a diagnosis. Progress should be monitored to ascertain neurological recovery or decline in order to understand potential outcomes and establish an optimal plan of care (1B).

1.2 We recommend examiner training to increase the accuracy of ISNCSCI assessment; training is available at the American Spinal Injury Association (ASIA) learning center (1C).

1.3 We recommend that algorithms be used for ISNCSCI grading to improve accuracy of classification (1C).

1.4 We recommend that a baseline neurological assessment be obtained within 24 hours to 1 week after initial injury (1B).

1.5 We recommend that neurological status be reevaluated within the first year after spinal cord injury (SCI) and monitored throughout the life span as needed (1B).

1.6 We recommend that the neurological examination be used to guide clinical reasoning related to the prognosis of neurological recovery. We recognize that there is considerable variability in SCI presentation and that multiple factors beyond the ISNCSCI examination (e.g., age, family support, education, socioeconomic status [SES]) should be considered in determining prognosis (1B).

1.7 We recommend that health care providers and scientists continue to evaluate emerging evidence related to neurological recovery after SCI, as there is ongoing research on additional factors that predict neurological recovery (1D).

2. Functional Outcomes

2.1 Respiratory

2.1.1 We recommend the evaluation of respiratory function in the acute phase, including functional assessment of respiratory muscles based on standardized measurement of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), or peak expiratory flow rate (especially during cough); negative inspiratory force, also known as maximal inspiratory pressure; respiratory complaints; physical examination of the respiratory system; chest imaging as indicated; pulse oximetry; accurate neurological level; and extent of injury (1B).

2.1.2 We recommend that respiratory management of individuals with SCI who are ventilated and those with the capacity to wean from ventilators be managed on the basis of published guidelines for aggressive acute injury assessment and management. Specifically, clinical pathways with a structured respiratory protocol that includes a combination of treatment techniques should be used to reduce respiratory complications and cost (1C).

2.1.3 We recommend when undertaking ventilator weaning in an individual with cervical SCI that management include use of a progressive ventilator-free breathing protocol regimen of relatively high-volume ventilation combined with medication optimization, noninvasive ventilation, and aggressive pulmonary secretion management (1D).

2.1.4 We recommend screening individuals with acute and chronic SCI for dysphagia and sleep-disordered breathing. Those with positive results should undergo more detailed assessment (1D).

2.1.5 We recommend that respiratory muscle training be encouraged for maintaining lung compliance and increasing chest expansion, strengthening inspiratory muscles to facilitate breathing with lower energy expenditure, and promoting prompt elimination of pulmonary secretions (1B).

2.2 Bowel – Neurogenic Bowel

2.2.1 We recommend that health care providers, individuals with SCI, and caregivers be aware that neurogenic bowel dysfunction (NBD) affects individuals with SCI physically, functionally, and psychosocially and that this affects overall health (1B).

2.2.2 We recommend the evaluation and implementation of an appropriate bowel management plan, with regular monitoring of NBD, to maintain health, improve quality of life (QOL), and facilitate participation in social and daily activities (1C).

2.2.3 We recommend ongoing education and adequate training of health care providers, individuals with SCI, and caregivers for the evaluation and management of NBD to facilitate appropriate bowel management that will prevent bowel complications over the life span of the individual with SCI (1D).

2.2.4 We recommend that individuals with SCI be engaged in discussions about their health beliefs, behaviors, and preferences to be able to successfully treat NBD, minimize complications, and improve QOL and outcomes of NBD (1D).

2.3 Bladder – Neurogenic Bladder

2.3.1 We recommend the regular monitoring of neurogenic bladder and its sequelae, as implementation of appropriate bladder management is crucial in maintaining bladder health and overall health (1B).

2.3.2 We recommend that prevention of bladder complications (e.g., urinary tract infection [UTI], vesicoureteral reflux, upper tract deterioration) be prioritized to prevent morbidity and mortality in individuals with SCI (1B).

2.3.3 We recommend that individuals with SCI be involved in the decision making and selection of the preferred method of bladder management, not only to preserve QOL and satisfaction, but also to prevent neurogenic bladder complications (1C).

2.4 Sexual Health

2.4.1 We recommend that clinicians provide information, resources, and referrals as appropriate to address sexual functioning, socialization, and psychological issues associated with sexual health after SCI (1C).

2.4.2 We suggest that individuals with SCI be provided with resources about sex and sexuality after SCI, including information about where to find accurate public access information and how to identify it, for themselves and their partners (2C).

2.4.3 We recommend that clinicians provide education and referrals related to reproductive options to achieve or prevent pregnancy as desired by the individual with SCI (1D).

2.4.4 We recommend that women with SCI consult early with an OB/GYN experienced in high-risk pregnancies, as women with SCI who become pregnant are at high risk for complications (1D).

2.4.5 We recommend that women with SCI receive access to occupational therapists, as well as knowledgeable lactation consultants, to optimize parenting outcomes after giving birth (1C).

2.5 Seated Activities (Bed Mobility, Bed and Wheelchair Transfers, and Positioning and Pressure Redistribution)

2.5.1 We recommend transfer and seated balance training for all individuals with SCI who have weakness in their trunk or upper extremities (1D).

2.5.2 We recommend that seated balance training be task specific, as outcomes may vary for different surfaces (1C).

2.5.3 We recommend that rehabilitation and training focus on optimizing independence and preventing injury, as well as taking into consideration comorbidities and potential for neurorecovery (1D).

2.6 Wheeled Mobility

2.6.1 We recommend that the provision of wheelchair services should include a wheeled mobility evaluation, fitting, configuration, adjustment, programming, and use training in wheelchair maintenance and skills. This process should be facilitated by a physical or occupational therapist experienced with SCI or neurological populations (1B).

2.6.2 We recommend that individuals with SCI be prescribed complex rehabilitation technology that includes individually configured manual and/or power wheelchairs with appropriate seating systems. These specialized devices should be tailored to the user's specific needs to maximize their function, independence, community participation, and mobility while minimizing risks related to skin and joint integrity (1B).

2.6.3 We recommend that manual wheelchair users be prescribed an ultralight weight manual wheelchair that is fully customizable (adjustable and/or configurable) and minimizes overall weight (1B).

2.6.4 We recommend that wheelchairs be equipped with assistive propulsion systems (e.g., power-assist wheels) to reduce the risk of repetitive strain or overuse injuries and improve independence and community participation, in the context of aging or other comorbidities such as obesity (1D).

2.6.5 We recommend that power wheelchair users be prescribed a wheelchair that includes batteries intended to last a full day before charging, has speeds appropriate for community access and navigation, and has electronics that accommodate seating functions (e.g., power tilt, power recline, power elevating legs, and/or power seat elevation) (1B).

2.6.6 We recommend that the seating system (seating cushions, postural supports, and accessories) for both manual and power wheelchairs be customized to the user (1B).

2.6.7 We recommend that consistent wheelchair maintenance is necessary to optimize performance and health outcomes (1C)

2.6.8 We recommend that individuals with SCI receive wheelchair re-evaluation at regular intervals to ensure proper fit, ergonomic set-up, and postural stability over time (1C).

2.7 Walking

2.7.1 We recommend regular evaluations of sensory and motor function to monitor change in neurological status that may be the basis for modifying the plan of care. This may include a complete ISNCSCI or portions of the examination to help with clinical reasoning related to determining a prognosis for ambulation (1D).

2.7.2 We recommend balancing potential neurorecovery with optimizing independence in mobility in the context of a limited amount of time in rehabilitation, considering the mode of mobility at discharge and at 1 year (whether walking, using a wheelchair, or a combination of these) (1D).

2.7.3 We recommend, when the plan of care includes ambulation training, that interventions be initiated early and include principles to maximize neuroplasticity such as intensity, repetition, and task specificity (1B).

2.7.4 We recommend the use of comprehensive clinical prediction rules that consider multiple clinical and personal factors and body functions (1B).

2.8 Arm and Hand Function (Eating, Grooming, Dressing, Toileting and Bathing)

2.8.1 We recommend assessing for neuropathic or musculoskeletal pain that can limit upper extremity function and providing education about upper extremity preservation techniques to prevent functionally incapacitating pain (1B).

2.8.2 We recommend interventions to increase flexibility, strength, and endurance for the upper extremities for all individuals after SCI, during initial rehabilitation, and during the life span (1C).

2.8.3 We recommend combining task-specific training, weight-bearing, and whole-body strengthening, augmented by electrical stimulation where appropriate, to increase the potential for improvement in upper extremity outcomes after acute and chronic SCI (1D).

2.9 Transportation and Driving

2.9.1 We recommend that individuals with SCI have access to information and training in the use of accessible transportation options early in their rehabilitation (1C).

2.9.2 We suggest that opportunities be provided for participation in an adapted driver education program as a way of increasing confidence in ability to drive for individuals with SCI who have the physical and cognitive capacity for driving (2C).

2.10 Skin Care Behaviors (e.g., Pressure Redistribution, Skin Checks, Proper Positioning, Limiting Uptime)

2.10.1 We recommend that prevention of pressure injuries (PIs) be prioritized and that the health care team address underlying risk factors, including decreased mobility, loss of sensation, neurogenic bladder and bowel, spasticity, susceptibility to infections and hospital admissions, smoking, diabetes, obesity, malnutrition, and polypharmacy (1C).

2.10.2 We recommend that education be provided to individuals with SCI and their caregivers about skin health, the need for daily skin monitoring and reporting of skin changes, and prevention of PIs throughout their lifetime (1D).

2.10.3 We recommend the early evaluation and management of PIs, correction of underlying risk factors, provision of appropriate equipment, and identification of cellulitis or osteomyelitis to prevent progression and promote wound healing (1D).

2.10.4 We recommend that clinicians identify all relevant person-specific risk factors and evaluation considerations for PI development when developing a plan of care for individuals after SCI in hospital and in community practices. This includes differences in ability to recognize skin changes in individuals with darker skin tones (1D).

2.10.5 We recommend the use of telehealth to evaluate skin breakdown. A clinic visit can be scheduled subsequently if necessary (1D).

2.10.6 We recommend that appropriate equipment (e.g., wheelchairs, seating systems, hospital beds and support surfaces, bathing and toileting equipment) be procured by qualified professionals at the time of acute or rehabilitation hospital discharge (1D).

2.10.7 We recommend that changes in posture, body conformation and weight, friction and shear forces, and skeletal deformities be addressed relative to positioning in a wheelchair, bed, and other sitting surfaces such as a commode or shower chair (1D).

2.10.8 We recommend that alternating pressure air surfaces and reactive gel surfaces for bed mattresses be provided to prevent and reduce the risk of PIs and to facilitate healing (1D).

2.10.9 We recommend that wheelchair pressure redistribution maneuvers be completed as often as possible, at least every 30 minutes during sitting. For power wheelchair users, this includes use of power tilt and power recline, or power standing, and for manual wheelchair users or those without power seating functions, this includes forward and lateral weight shifts (1A).

2.11 Quality of Life

2.11.1 We recommend baseline assessment and periodic monitoring of health-related QOL, using standardized assessments that have robust psychometric properties when used in individuals with SCI (1D).

2.11.2 We recommend that individuals with SCI who have poor health-related QOL be referred to clinicians who are skilled at addressing behavioral health needs and limitations in physical functioning, as well as to community resources to improve vocational, economic, and social well-being (1D).

2.11.3 We recommend that clinicians monitor for abuse, neglect, and violence by using disability-specific measures and, if detected, provide appropriate reporting, resources, and referrals (1D).

2.11.4 We recommend that interventions focus on modifiable factors that may influence health-related QOL, including encouraging regular physical activity consistent with evidence-based exercise guidelines for adults with SCI (1D).

2.11.5 We recommend that clinicians be aware that individuals with SCI can have high health-related QOL and that they promote this expectation to their patients (1D).

2.12 Community Participation (including participation in school or employment)

2.12.1 We recommend that clinicians work with individuals with SCI and their social networks to identify and address modifiable factors that influence community participation and facilitate their optimization, including education, psychological health, social support, and the built environment (1C).

2.12.2 We recommend that individuals with SCI become engaged with rehabilitation professionals, social workers, peer mentors, and community organizations to facilitate awareness of and access to resources and social support, as well as opportunities for adaptive physical and recreational activities (1C).

2.12.3 We recommend that clinicians with appropriate training evaluate home, community, school, and work environments for ease of use and modification which may enhance access, safety, and independence of individuals with SCI (1C).

2.12.4 We recommend that social workers or counselors assess the interest of individuals with SCI in education and facilitate referrals and supports for the completion of secondary, undergraduate, and graduate degrees (1B).

2.12.5 We recommend that clinicians encourage individuals with SCI to engage with peer mentors and offices of Disability Support Services in postsecondary education to facilitate disability accommodations and supports (1D).

2.12.6 We recommend that health care systems integrate vocational rehabilitation counselors as part of the multidisciplinary SCI health care team. When this is not feasible, we recommend that clinicians refer the individual with SCI to vocational counseling and vocational rehabilitation services, as well as to relevant community resources (1B).

2.12.7 We recommend that individuals with SCI have access to employment-related planning and resources that center around their specific skills, functional capabilities, interests, and concerns (1C).

2.12.8 We recommend that individuals with SCI be provided with support to facilitate the completion of the activities of daily living required to prepare for and participate in employment activities, including those associated with management of health in employment environments (1C).

3. Outcome Modifiers (Correlations Identified in the Literature)

3.1 Societal Attitudinal Factors

3.1.1 We recommend that clinicians critically evaluate their health care processes for personal and systemic biases that affect both access to care and the quality of care provided to individuals with SCI on the basis of, for example, gender, race, ethnicity, sexual orientation, education, weight, religion, age, and disability (1C).

3.1.2 We recommend that clinicians participate in implicit bias training to identify their own areas of unconscious bias and take steps to challenge assumptions perpetuated through systemic processes based on, for example, race, ethnicity, gender, disability, religion, and sexual orientation (1D).

3.1.3 We suggest that clinicians be knowledgeable about their legal responsibilities toward individuals with SCI and other disabilities, as identified through the Americans with Disabilities Act (ADA), Section 1557 of the Affordable Care Act, and other federal policies and statutes (2D).

3.1.4 We recommend the collection of data about, for example, race, ethnicity, and sexual orientation based on self-report rather than by assumptions or information from the medical record (1D).

3.1.5 We recommend assessment and documentation of the patient's proficiency in speaking and writing English, as well as the preferred spoken language needed for effective communication with health care providers, including appropriate accommodations (1D).

3.2 Environmental Factors

3.2.1 We recommend the evaluation and modification of home, outdoor, and workplace environments as needed to enhance access, independence, and participation for individuals with SCI (1C).

3.3 Spasticity

3.3.1 We recommend screening for problematic spasticity at regular intervals and that individuals with positive results undergo more detailed assessment, including identification of extrinsic causes (1B).

3.3.2 We recommend that the impact of problematic spasticity on comfort, functional activities, independence, burden of care, and QOL be evaluated and addressed (1B).

3.3.3 We recommend providing education on integrating nonpharmacological spasticity management options, such as stretching, exercise, and activity, into daily activities to improve comfort and QOL (1C).

3.3.4 We recommend that clinicians document the impact of spasticity by using standardized assessment before and after therapeutic interventions (1B).

3.4 Pain

3.4.1 We recommend that health care providers use current clinical practice guidelines (CPGs) to treat SCI-related pain, in part because treating pain can improve physical and psychological functioning (1A).

3.4.2 We recommend that clinicians use standardized measures to assess pain, including pain intensity and pain interference with physical and psychological functioning such as sleep and mood (1C).

3.5 Bone Density

3.5.1 We recommend that health care providers assess fracture risk at least annually (1B).

3.5.2 We recommend assessment of non-bone mineral density (BMD) risk factors for fracture following a change in functional abilities, minor injury after a fall, or a fragility fracture (1B).

3.5.3 We recommend assessment of lower extremity regional fracture risk with consideration for prior fracture history and BMD in the regions of the hip, distal femur, and proximal tibia (1B).

3.5.4 We recommend providing fall prevention education, transfer and wheelchair skills training, and/or balance training to individuals with SCI who have experienced a fall to reduce fall risk and increase confidence in community participation (1D).

3.6 Health Management Behaviors and Adherence

3.6.1 We recommend providing self-management training to enhance health outcomes and associated self-efficacy and psychosocial factors (1D).

3.6.2 We recommend the use of multi-modal support strategies, including education, motivational interventions, peer mentoring, adapted activities, and digital health tools, to enhance therapy participation, mastery of self-care skills, self-efficacy, and long-term health outcomes (1C)

3.7 Comorbid Mental Health Conditions (e.g., Depression, Anxiety, Post-Traumatic Stress Disorder, Substance Use Disorders)

3.7.1 We recommend that health care providers screen individuals with SCI for mental health and substance use-related problems at regular intervals and those with positive screens should undergo more detailed assessment. 1D

3.7.2 We recommend that health care providers should treat individuals with SCI for comorbid mental health or substance use disorders to improve health outcomes and reduce mortality. 1D

3.8 Body Mass Index and Body Habitus

3.8.1 We recommend providing education about and monitoring of PIs in individuals with SCI who are overweight or underweight because of their increased risk (1C).

3.8.2 We recommend that a body mass index (BMI) of ≥ 22 kg/m2 be used as the cutoff point for obesity when BMI is used as a surrogate marker for obesity in individuals with SCI (1B).

3.9 Physical Inactivity, Deconditioning, and Sedentariness

3.9.1 We recommend screening for physical inactivity and use of evidence-based interventions to help individuals with SCI meet physical activity guidelines when possible (1D).

3.10 Age

3.10.1 We recommend considering age at injury onset, as well as aging with an SCI, when determining outcomes for individuals with SCI (1C).

3.11 Cognition (Cognitive Impairment, Neurocognitive Influences)

3.11.1 We recommend screening for cognitive and executive dysfunction throughout the life span and provision of appropriate evidence-based treatment (1D).

3.11.2 We suggest that clinicians recognize risk factors for cognitive impairment in individuals with SCI, including age >60 years, depression, anxiety, pain, fatigue, medication side effects, decentralized cardiovascular control (including orthostatic hypotension and autonomic dysregulation), and neuromuscular respiratory disorder (including hypoventilation, sleep-disordered breathing, and sleep apnea) (2D).

3.12 Orthopedic Polytrauma and Upper Limb Pain

To reiterate and remain in harmony with the Consortium for Spinal Cord Medicine CPG titled Preservation of Upper Limb Function Following Spinal Cord Injury (Boninger et al., 2005):

3.12.1 We recommend monitoring for upper extremity repetitive use injuries and pain, particularly among users of manual wheelchairs and users of upper extremity assistive devices for ambulation (1C).

3.12.2 We suggest education and training for those at risk for upper extremity pathology due to repetitive use, including discussion of the pros and cons of using power assist or powered mobility (2C).

3.13 Use of Adaptive Technology

3.13.1 We recommend exposing people with SCI to evidence-informed internet resources that expand knowledge about health information, employment, communication, and improved self-care

3.13.2 We recommend exposing people with SCI to assistive technology in acute care and inpatient rehabilitation to have the most salient impact on functional outcomes

3.13.3 We recommend adaptations and specialized assistive technology that is congruent with functional abilities

3.13.4 We recommend addressing AT needs in people who have been shown to experience barriers to computer and assistive technology (non-White, older age, greater injury severity, lower educational levels, greater time since injury).

3.13.5 We recommend providing information about federal, state, and local resources for assistance with funding assistive technology

3.14 Socioeconomic Status

3.14.1 We recommend that a case manager or social worker be included in the SCI health care team in both inpatient and outpatient settings to facilitate access to resources (1D).

3.15 Influence of Standard Rehabilitation

3.15.1 We recommend that individuals with SCI receive specialized SCI care, including a multidisciplinary rehabilitation program (1A).

3.15.2 We suggest that inpatient rehabilitation clinicians monitor and encourage their patients to participate in therapy to optimize outcomes (1D).

3.16 Traumatic vs. Nontraumatic SCI

3.16.1 We recommend that clinicians consider prognostic indicators described for traumatic SCI when developing a plan of care for individuals with either traumatic or nontraumatic SCI (1D).

Methods

Searching the Literature

A methodology that properly elucidated predictors for function and specific outcomes after SCI across an extremely wide variety of topics to address the 55 key questions identified by the panel required a creative, flexible, and customized approach that a standardized systematic review could not address. Appendix A has the entire list of the key questions with associated keyword terms that were addressed in searching the literature.

The literature search protocol developed and used by the methodology team was as follows. As most of the literature search was keyword based, we used PubMed for the majority of searches. Our keyword searches included "spinal cord injury" plus the clinical area that we were searching for (e.g., "upper limb," "arm," or "hand") paired with "factors," "predictors," "function," or "outcomes," or a combination thereof, depending on which key question we were answering. For example, for the key question "What are the factors associated with better bowel outcomes?" the keyword "factors" OR "predictors" was used in combination with "spinal cord injury," "bowel," and "outcomes." Search terms were expanded if necessary (e.g., switching factors with predictors, or using specific words associated with common bowel conditions experienced by the SCI community such as constipation or incontinence).

In an effort to distill the massive amount of literature that needed to be reviewed for this document, we used a sliding scale of inclusion for relevant articles. For predictor- or factor-type questions, we started with n=1,000 as a minimum sample size; if we found few or no articles that answered the key question, the minimum sample size was adjusted downward to n=500, and then n=100, as required. For questions that needed data from clinical or randomized controlled trials (RCTs), we started with a minimum sample of n=50 and moved downward as necessary. Studies with smaller sample sizes were included only if they were referenced by systematic reviews, if there was a lack of information that addressed the key question, and/or if they studied something particularly relevant to the key question as determined by the methodology team. In some sections with extensive literature, the panel requested that only systematic reviews of predictors or outcomes be included. To further elucidate key findings, we included larger studies that were cited by the systematic reviews in order to clearly reference the findings from the first cited literature.

Other limits imposed to find the specific literature needed to answer key questions included publication dates (by last 5 years, by last 10 years, etc., on a sliding scale depending on what was found), article type (e.g., predictors or factors generally came from retrospective data reviews or correlational studies), articles that studied humans, and articles that were published in English only. In an attempt to ensure that the articles included would be relevant to the American social context, we favored articles that were published in the United States; however, articles published in Western regions such as Canada, Europe, and Australia or New Zealand were also considered. Articles from other countries were included only if they contributed something particularly relevant to the clinical area and/or if no other literature was available that addressed that particular key question.

If at this point the key question was still not answered sufficiently, we entered the best studies into PubMed and used the "Article cited by" and the "Similar articles" features on PubMed to find and screen additional relevant articles. Reference sections of already included papers were hand searched to find additional articles that would address the key question and also meet the inclusion criteria of sample size, country of origin, and prescribed outcomes (i.e., predictors, function).

The methodology team would discontinue searching or performing further data extraction if they felt that the largest and most scientifically relevant and valid articles had already been included (i.e., saturation). If an article was not included (e.g., if it was older [pre-2000], or did not exactly fit the inclusion criteria), but the panel members felt it was relevant to answering the key question, they were encouraged to include and base recommendations on that article. Panel members had access to all the individual articles and were also encouraged to review key articles

specifically and directly, rather than relying solely on the methodology team's data extraction, to ensure that information was interpreted correctly and that proper recommendations could be made.

Every effort has been made to include papers that address multiple key questions in appropriate sections. In other words, if a paper addressed both neurological recovery and walking, then the paper would have been extracted into both the neurological recovery section and the walking section. Panel members were encouraged to share with each other if they determined that extracted data or outcomes from their section would be relevant to another key question.

Further Restrictions on the Search
The social context of some fields was specific to the country under study. For this reason, studies from the United States were prioritized for the topic of socioeconomic status (SES), insurance status, and cost-effectiveness questions.

Studies Brought Forward by the Panel
The panel used their clinical judgement to bring forward any additional studies with any sample size and from any country that they felt were relevant.

Type of Studies Included

The intent of this guideline was to determine the prediction or association of select outcomes with usual care or best practice, rather than to search for clinical trials that evaluate the effect of an intervention. Given that the focus of this guideline was on factors influencing outcome, the types of articles were primarily correlational or predictive studies.

For background knowledge, there were a small number of questions related to the outcomes after a specific training intervention. For these questions (e.g., Does participation in locomotor training in the inpatient rehabilitation phase influence walking outcomes?), systematic reviews or meta-analyses were sought. As intervention data were not the primary purpose of this guideline, these studies were not rated for methodology. Although systematic reviews can be considered the highest level of evidence, the panel was cautious in their interpretation, as several of these systematic reviews consisted of a small number of studies with very low sample sizes.

Correlation or Predictive Data
Examples: What factors predict walking outcomes? What factors are related to successful employment?

Minimum sample size: 1,000 in total

Design: correlational, regression, survey

Countries: Priority was given to studies from the United States, Canada, United Kingdom, Australia, and Europe.

Smaller samples were considered if there were no studies of 1,000 or more supporting these topics (and then studies of 500, and then 100, etc.).

Some fields had extensive data and only systematic reviews of the correlations or predictors were extracted (e.g., QOL, community integration).

Grading of the Evidence

The Grades of Recommendations Assessment, Development and Evaluation Working Group (GRADE Working Group) was used as a system for grading the quality of evidence. In GRADE, individual studies are first assessed for bias based on random sequence generation, allocation concealment, blinding of outcome assessments, freedom from systematic differences in baseline characteristics, adjustment for baseline differences in their analysis, and attrition bias. Correlational studies lack the first 5 of these points, and thus individual correlational studies were considered to have high bias. For example, a strong association between less pain and insurance funding does not necessarily mean that providing an individual with insurance funding will lead to less pain.

Following the grading of individual papers, the risk of bias is then assessed over the body of literature. The highest quality rating is for a body of literature with randomized trial evidence, and the evidence is downgraded to moderate, low, or very low-quality evidence, depending on the presence of the following:

1. Limitations in the design and implementation of available studies, suggesting a high likelihood of bias.

2. Indirectness of evidence (indirect population, intervention, control, outcomes).

3. Unexplained heterogeneity or inconsistency of results (including problems with subgroup analyses).

4. Imprecision of results (wide confidence intervals).

5. High probability of publication bias.

The supporting body of evidence from the correlational studies in this review were considered "very low" quality. The body of evidence for each of the questions in this review was downgraded at least 3 times to "very low" quality because of the following limitations:

- The majority of studies lacked confidence intervals or any measure of precision of the results.
- None of the studies controlled for potential confounds.
- The majority of studies had a small sample size.
- Loss to follow-up was rarely, if ever, reported.
- There was wide heterogeneity in the participant populations studied in terms of time since injury, type of SCI, and varying times of follow-up.

Grading Clinical Practice Guidelines Using the GRADE System

Development of Recommendations for This Clinical Practice Guideline
The panel presented and discussed draft recommendations at an in-person meeting in October 2022. We revised the recommendations to reflect the comments of panel members, and the revised versions were disseminated electronically to the group for additional comments, review, and discussion until final recommendations were approved.

The panel assigned a grade for each recommendation based on a modified GRADE system. Each recommendation includes both the **numerical** strength of the quality-of-evidence grade and the **letter** panel assessment of the strength of the recommendations. Table 1 describes the quality and strength of evidence and the designation and wording stipulations.

Grading of Recommendations: Quality of Evidence and Strength of Panel Opinion

The **quality of evidence** is described as A (high), B (moderate), C (low), or D (very low). For correlational data, confidence in the findings of the study is based on sample size, as described earlier.

The **strength of recommendation** is described by letters: 1 (strong), 2 (conditional), or 3 (weak).

Consensus Recommendations

Consensus processes were used to arrive at the wording for contentious recommendations. Majority votes of at least 70% agreement supported 101 of the 166 initial recommendations. Those recommendations for which there was not a 70% majority agreement were removed, with the option for a panel member to rescue the recommendation by rewording it to obtain panel acceptance. In the final electronic voting, 78 recommendations received 100% support, 16 received 90% support, and 7 received 80% support.

Following peer review by 9 members of partner organizations within the Consortium for Spinal Cord Medicine, 2 new recommendations were developed, 9 recommendations underwent wording revisions for clarity, 0 recommendations without sufficient evidence were removed. A revote was held on additions and revisions to the recommendations based on reviewer feedback, resulting in the presentation of 103 recommendations in the final clinical practice guideline (CPG).

The nature of the evidence for the recommendations in this CPG is primarily observational and/or relies heavily on the consensus of experts. The wording **"we recommend"** infers strong recommendations that can apply to most patients in most circumstances. The wording **"we suggest"** infers a conditional recommendation for which the best action may differ depending on patient circumstances or societal values.

Table 1. Grading of Quality and Strength of Evidence

	Benefits vs. Risk and Burdens	Methodological Strength of Evidence	Implications for Practice: Wording of Recommendation
1A = high-quality evidence, strong recommendation	Benefits clearly outweigh risk and burden or vice versa	Consistent evidence from RCTs without important limitations or exceptionally strong evidence from observational studies	Recommendation can apply to most patients in most circumstances. "We recommend . . ."
1B = strong recommendation, moderate evidence	Benefits clearly outweigh risk and burden or vice versa	Evidence from RCTs with important limitations (inconsistent results, methodological flaws, indirect or imprecise) or very strong evidence from observational studies	Recommendation can apply to most patients in most circumstances. "We recommend . . ."
1C = strong recommendation, low-quality evidence	Benefits clearly outweigh risk and burden or vice versa	Evidence for at least 1 critical outcome from observational studies, case series, RCTs with serious flaws, or indirect evidence	Recommendation can apply to most patients in many circumstances. "We recommend . . ."
1D = strong recommendation, very low-quality evidence	Benefits clearly outweigh risk and burden or vice versa	Evidence has significant flaws. Expert opinion includes evidence in the context of experts' experiences and knowledge or experts' interpretation of uncontrolled case series (e.g., in own practice)	Recommendation can apply to most patients in many circumstances. "We recommend . . ."
2A = weak recommendation, high-quality evidence	Benefits closely balanced with risks and burden	Consistent evidence from RCTs without important limitations or exceptionally strong evidence from observational studies	The best action may differ depending on patient circumstances or societal values. "We suggest . . ."
2B = weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burden	Evidence from RCTs with important limitations (inconsistent results, methodological flaws, indirect or imprecise) or very strong evidence from observational studies	The best action may differ depending on patient circumstances or societal values. "We suggest . . ."
2C = weak recommendation, low-quality evidence	Uncertainty in the estimates of benefits, risk, or burden	Evidence for at least 1 critical outcome from observational studies, case series, or RCTs with serious flaws or indirect evidence	Other alternatives may be equally reasonable. "We suggest . . ."
2D = weak recommendation, very low-quality evidence	Very little confidence in estimates of benefits, risk, or burden	Lack of evidence for at least 1 critical outcome from observational studies, case series, or RCTs with serious flaws or indirect evidence	Other alternatives are not able to be assessed. "One may . . ."

Abbreviation: RCTs, randomized controlled trials.

Section 1: Recommendations and Rationales

1. Neurological Outcomes

Panel Findings

- The International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) is a reliable and valid tool to assess neurological function and to classify SCI.
- There is a potential for individuals to have neurological recovery that results in a change in American Spinal Injury Association (ASIA) Impairment Scale (AIS) classification and/or neurological level of injury.
- Neurological recovery is most pronounced within the first 3 months after SCI, continues through the first year after injury, and may extend beyond a year in some individuals.
- Factors that can provide the most valuable information related to prediction of neurological recovery include AIS classification, sacral sparing, motor function, sensory function, zone of partial preservation (ZPP), and age.
- The majority of injuries initially classified as AIS A will remain AIS A. However, approximately 20%-30% will improve, with 50% of these progressing to AIS B and 50% to AIS C or D.
- Progression from complete AIS A SCI to incomplete SCI occurs more in individuals with tetraplegia than in those with paraplegia. For paraplegia, this improvement from complete to incomplete is more likely to occur in lumbar vs. thoracic injuries.
- Individuals with an initial injury classification of AIS B demonstrate variability in improvements in AIS classification within the first year after injury.
- Individuals with SCI classified as AIS C are more likely to improve to AIS D than are individuals with an initial injury classification of AIS A or B.
- The majority of individuals with an initial injury classification of AIS C improve to AIS D or E within the first year after injury.
- The more components of sacral sparing that are present, the greater the potential to improve to a higher AIS level.
- The extent of motor and sensory ZPPs is indicative of neurological recovery potential, with longer ZPPs associated with higher likelihood of neurological improvement.
- Studies using the ISNCSCI exam to track sensory and motor recovery do not consistently include data on how these changes relate to changes in function; and functional gains can occur without change in ISNCSCI scores.

Synopsis of Evidence

Neurological Recovery After Traumatic SCI. Kirshblum et al. (2021) completed a comprehensive review on natural recovery after traumatic SCI, reviewing the literature available on neurological outcomes after SCI by using the ISNCSCI and the AIS. The framework of the review includes levels of injury and severity of injury when describing recovery patterns, and the information is presented in this clinical practice guideline (CPG) by using similar schema. These data summarize information available from the 1990s to 2021.

Assessment of Neurological Outcomes in SCI. The ISNCSCI and resulting AIS have been the primary tools used to evaluate and classify neurological function in individuals with SCI in both clinical and research settings (Kirshblum et al., 2021). These assessments are valid and reliable tools for objective and standardized neurological assessment and monitoring of SCI in the acute, subacute, and chronic stages of SCI (Furlan et al., 2011). The ISNCSCI and AIS have been used for clinical and research purposes to determine prognosis and outcomes in SCI (Steeves et al., 2007, Kirshblum et al., 2020). Nevertheless, there are well-recognized limitations of the ISNCSCI and AIS (Krishna et al., 2014), including patient participation (Burns et al., 2003) and examiner skill and training (Osunrobi and Sharma, 2019; Armstrong et al., 2017; Furlan et al., 2011).

Adequate training is required to be able to perform the ISNCSCI assessment in a valid and reliable manner. Training provides an understanding of the various components and rules, as well as the knowledge and skills needed to complete the assessment accurately (Kirshblum et al., 2021; Osunrobi and Sharma, 2019; Armstrong et al., 2017; Schuld et al., 2013, 2015). Computational algorithms are available to assist with completing the ISNCSCI and AIS calculations (e.g. see https://www.isncscialgorithm.com). Evidence suggests that an initial ISNCSCI assessment performed within 24 hours to 1 week after SCI in cognitively intact individuals provides the most consistent

prognostication for functional and neurological outcomes (Kirshblum et al., 2021). Table 2 describes what is known about conversion of various AIS injury grades from initial assessment to discharge from rehabilitation, and at 1 year after injury. Given that motor and sensory status may evolve over time (i.e., due to natural recovery, treatment effects, or secondary complications) reassessment at key time points—such as when changes are noticed or when new therapies are initiated—provides valuable information for ongoing management

AIS CONVERSION

Conversion After Complete SCI (AIS A). Data reveal that there has been an increased likelihood of neurological improvement over the last 30 years (Devivo et al., 2007). A change from one AIS classification to another is referred to as "conversion." Following an acute SCI, evidence indicates that the majority of recovery occurs within the first 3 months; recovery continues, however, throughout the first post-injury year (Steeves et al., 2011). Among individuals with SCI, 30%-60% are initially classified as having complete SCI (AIS A; Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009). In individuals with injury initially classified as AIS A, approximately 15%-20% improve (or convert) to incomplete at discharge from inpatient rehabilitation (Devivo et al., 2007; Kirshblum et al., 2016), and 20%-30% improve (or convert) to incomplete SCI, either AIS B (50%) or AIS C or D (50%) within the first year (Marino et al., 1999; Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009; Fawcett et al., 2007).

Progression from complete SCI (AIS A) to incomplete SCI (AIS B-D) occurs more in individuals with tetraplegia than in those with paraplegia (Steeves et al., 2011; Fawcett et al., 2007; Coleman and Geisler, 2004). Moreover, this improvement occurs most frequently in lumbar SCI, followed by cervical and lower thoracic SCI (Khorasanizadeh et al., 2019; Marino et al., 1999; Kirshblum et al., 2016; Zariffa et al., 2011; Fawcett et al., 2007; Coleman et al., 2004; Lee et al., 2016; Harrop et al., 2011; Aimetti et al., 2019). Just over 13% of individuals with injury classified as AIS A at the time of discharge from inpatient rehabilitation improve to incomplete within the first year after injury as follows: 5.6% to AIS B, 3.5% to AIS C, 4.1% to AIS D 4.1%, and <1% to AIS E (Kirshblum et al., 2011). Improvement is less between 1 and 5 years after injury, with only 5.6% progressing to incomplete SCI (Kirshblum et al., 2004).

AIS A Tetraplegia. For individuals with tetraplegia initially classified as AIS A, approximately 30% will improve within the first year; of these, 50% will convert to AIS B and 50% will convert to AIS C or D (Marino et al., 2011; Steeves et al., 2011; Kirshblum et al., 2016). For individuals with SCI classified as AIS A at rehabilitation discharge, 14% improve to incomplete SCI within the first year as follows: AIS B, 7.3%; AIS C, D, or E, 7.1%. Of individuals with complete tetraplegia at 1 year after injury, 9.1% showed limited progression to incomplete tetraplegia within 5 years as follows: AIS B, 6.7%; AIS C or D, 2.4%. These data indicate that less conversion of AIS classifications occurs with increasing time since injury (Kirshblum et al., 2011).

AIS A Paraplegia. For individuals with paraplegia classified as AIS A, approximately 15%-20% progress to incomplete SCI within 1 year, with more distal levels of injuries demonstrating greater improvement. Upper and midthoracic (T2-T9) SCI show the least recovery, and lower thoracic (T10-T12) and lumbar complete SCI have the best likelihood of improvement to incomplete SCI (Lee et al., 2016; Harrop et al., 2011; Aimetti et al., 2019). Individuals with complete AIS A SCI paraplegia (12.8%) at rehabilitation discharge (~3 months) improve to incomplete SCI within the first year as follows: AIS B, 4.4%; AIS C, D, or E, 8.4%. For individuals with paraplegia whose injury classification remains AIS A at 1 year after injury, 96.4% remain complete at 5 years after injury (Kirshblum et al., 2004).

Conversion After Incomplete SCI (AIS B, C, or D). In general, approximately 13% of individuals with SCI have an initial injury classified as AIS B with incomplete sensory and complete motor loss (Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009). There is variability in the percentage of AIS improvement within the first year for this population (Kirshblum et al., 2021). Details based on type of injury (tetraplegia vs. paraplegia) are provided below. In individuals with injury initially classified as AIS B, 33.9%-45.2% convert at least 1 AIS level by discharge from inpatient rehabilitation (Kirshblum et al., 2016; Devivo et al., 2007). In general, for individuals with SCI classified as AIS B SCI at 1 year, 15.8% progressed to AIS C and 4.4% to AIS D, 31.6% regressed to AIS A, and 48.2% stayed at AIS B at 5 years (Kirshblum et al., 2004).

Table 2. Summary of Percentage Recovery of American Spinal Injury Association Impairment Scale (AIS) Levels at Discharge From Inpatient Rehabilitation and at 1 Year After Discharge From a Variety of Studies Investigating AIS Conversion

Initial Injury Classification	Discharge From Inpatient Rehabilitation	One Year
Conversion of AIS A to Sensory Incomplete (AIS B)		
AIS A	6% (Marino et al., 1999) 8% (Devivo et al., 2007) 12% (Marino et al., 2011) 13% (Kirshblum et al., 2016)	7% (Marino et al., 1999) 14 % (van Middendorp et al., 2009) 10% (Marino et al., 2011) 11% (Kirshblum et al., 2016)
AIS A Tetraplegia	19% (Kirshblum et al., 2016)	15% (Kirshblum et al., 2016)
AIS A Paraplegia	9% (Kirshblum et al., 2016)	8% (Kirshblum et al., 2016) 8% (Lee et al., 2016)
Conversion of AIS A to Motor Incomplete (AIS C or D)		
AIS A	5% (Marino et al., 1999) 7% (Devivo et al., 2007) 15% (Marino et al., 2011) 7% (Kirshblum et al., 2016)	8% (Marino et al., 1999) 12 % (van Middendorp et al., 2009) 15% (Marino et al., 2011) 17% (Kirshblum et al., 2016)
AIS A Tetraplegia	7% (Kirshblum et al., 2016)	19% (Kirshblum et al., 2016)
AIS Paraplegia	7% (Kirshblum et al., 2016)	16% (Kirshblum et al., 2016) 8% (Lee et al., 2016)
Conversion of AIS B to Motor Incomplete (AIS C or D)		
AIS B	55% (Marino et al., 1999) 45% (Devivo et al., 2007) 51% (Marino et al., 2011) 42% (Kirshblum et al., 2016)	73% (Marino et al., 1999) 73% (van Middendorp et al., 2009) 66% (Marino et al., 2011) 54% (Kirshblum et al., 2016)
AIS B Tetraplegia	39% (Kirshblum et al., 2016)	49% (Kirshblum et al., 2016)
AIS B Paraplegia	48% (Kirshblum et al., 2016)	62% (Kirshblum et al., 2016) 59% (Lee et al., 2016)
Conversion of AIS C to AIS D or E		
AIS C	54% (Devivo et al., 2007) 77% (Marino et al., 2011) 52% (Kirshblum et al., 2016)	71% (Marino et al., 1999) 74% (van Middendorp et al., 2009) 83% (Marino et al., 2011) 73% (Kirshblum et al., 2016)
AIS C Tetraplegia	58% (Kirshblum et al., 2016)	77% (Kirshblum et al., 2016)
AIS C Paraplegia	39% (Kirshblum et al., 2016)	61% (Kirshblum et al., 2016) 81% (Lee et al., 2016)

Among individuals with SCI, 15%-20% are initially classified as AIS C and 20%-30% as AIS D, although there may be some variability in these numbers due to timing of initial classification (Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009). Individuals with SCI initially classified as AIS C have higher rates of improvement to AIS D than do those with a baseline AIS classification of A or B. In individuals with an injury initially classified as AIS C, approximately 54.3% convert to AIS D by discharge from inpatient rehabilitation (Devivo et al., 2007). The likelihood of improvement from an initially AIS C to AIS D or E has been shown to be 85% within 1 year, with the remaining 10%-20% staying at AIS C and 8% regressing to AIS A or B (Marino et al., 1999; Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009). Individuals with AIS D injury classification primarily remain at AIS D or recover to AIS E, with 2% showing a decline to AIS A or B within 1 year (Marino et al., 1999; Spiess et al., 2009; Kirshblum et al., 2016; van Middendorp et al., 2009).

AIS B Tetraplegia. Among individuals with injury classified as AIS B tetraplegia at baseline, 50%-65% improved to motor-incomplete (AIS C or D) within 1 year, 25%-40% stayed unchanged at AIS B, and 10% declined to AIS A (Kirshblum et al., 2016; Marino et al., 2011). Another 22.3% with AIS B tetraplegia improved to motor-incomplete in 5 years (Kirshblum et al., 2004).

AIS B Paraplegia. In individuals classified at baseline with AIS B paraplegia, about 60% improved to motor-incomplete (AIS C or D) within 1 year and 10% declined to AIS A (Kirshblum et al., 2016; Lee et al., 2016). For individuals who remained at AIS B at 1 year, 11.9% progressed to AIS C, 4.8% progressed to AIS D, and 28.6% declined to AIS A within 5 years (Kirshblum et al., 2004).

AIS C or D Tetraplegia. Of individuals with SCI classified as AIS C tetraplegia within 30 days of injury, 80% improved to AIS D within 1 year of injury, 15% remained at AIS C, 1% regressed to AIS A, and 4% regressed to AIS B. All those who were initially classified as AIS D remained at AIS D or improved to AIS E within 1 year of injury (Kirshblum et al., 2016; Marino et al., 2011). At 1 year, 24.1% of individuals with AIS C tetraplegia improved to AIS D, 53.4% remained at AIS C, and 22.4% regressed to AIS A or B motor-incomplete within 5 years (Kirshblum et al., 2004). Most individuals with AIS D tetraplegia at 1 year (86.2%) stayed at AIS D and 13.8% converted to AIS A-C within 5 years (Kirshblum et al., 2004).

AIS C or D Paraplegia. Similar to those with motor-incomplete tetraplegia, the majority of individuals with motor-incomplete paraplegia with initial AIS C recovered to AIS D or E within 1 year, and most individuals with AIS D remained at AIS D within 1 year (Kirshblum et al., 2016; Lee et al., 2016; Harrop et al., 2011; Wilson et al., 2018). For individuals with AIS C SCI paraplegia at 1 year, 19.4% improved to AIS D, 62.9 % remained at AIS C, and 17.7% declined to AIS A or B motor-incomplete status within 5 years (Kirshblum et al., 2004). At 1 year, 80.7% of individuals with AIS D paraplegia remained at AIS D, 12% declined to AIS C, and 7.2% declined to AIS A or B within 5 years (Kirshblum et al., 2004).

AIS CONVERSION AND SACRAL SPARING

In a study of over 3,500 cases, Marino et al. (1999) concluded that individuals with motor-complete SCI who have sacral sparing are more likely to convert to motor-incomplete (53.6%) than are those who may have an extended ZPP, but without sacral sparing (3.6%). In a systematic review of 76 papers that investigated a variety of predictive outcomes in SCI, Sharif and Jazaib Ali (2020) reported that sacral sparing is a key predictor in improved neurological outcomes, especially pinprick (PP) preservation. The presence or absence of PP sensation likely explains some of the variability in recovery in individuals with AIS B (Marino et al., 1999). In a study of over 1,700 individuals with SCI that examined patterns of sacral sparing and relationship to neurological recovery, initial sacral sparing of all of the sensory components (deep anal pressure [DAP], light touch [LT], and PP in S45) correlated to conversion from AIS B to motor-incomplete at discharge from rehabilitation and at 1 year after injury (Kirshblum et al., 2016).

The presence of DAP alone, or the presence of sacral sensation alone, resulted in the lowest probability of conversion to motor-incomplete (Kirshblum et al., 2016). Similarly, in individuals with AIS C, the presence of all sacral sparing components (voluntary anal contraction [VAC], DAP, LT, or PP in S45) resulted in the greatest likelihood of conversion to AIS D by discharge from rehabilitation (66%). Voluntary anal contraction alone had the poorest prognosis for improvement to AIS D (Kirshblum et al., 2016). The same study concluded that sacral sparing of PP only was not found to be related to AIS conversion, although PP along with another component of sacral sparing did result in recovery more often (Kirshblum et al., 2016).

MOTOR RECOVERY

Following a robust review of the literature, Kirshblum et al. (2021) concluded that motor recovery primarily occurs in the first 6-9 months after SCI, with the fastest recovery occurring in the first 3 months. In individuals with complete tetraplegia, 70% recovered 1 motor level and 30% recovered 2 or more motor levels at 1 year. The same study reported a change in the upper extremity motor score (UEMS) at 1 year of 10-11 points, regardless of the initial motor level (Steeves et al., 2011, n=425). Similar findings related to recovery of motor levels concluded that 65% would improve by at least 1 motor level, with 20%-30% of those improving 2 or more motor levels. Conversely, 5% would regress by 1-3 motor levels and 30% would not change (Kirshblum et al., 2021). In persons with tetraplegia classified as AIS A, a change of 2 motor levels was associated with a clinically meaningful improvement in ability to perform functional activities in a sample of 74 individuals (Kramer et al., 2012). The amount of change needed to substantively influence functional performance in individuals with other injury classifications is not known.

For individuals with complete paraplegia, the level of injury is associated with motor recovery, in contrast to findings in complete tetraplegia (Steeves et al., 2011), and the overall change in the lower extremity motor score (LEMS) has been found to be minimal (Kirshblum et al., 2021). More specifically, in a study of individuals with thoracic complete SCI, Zariffa et al. (2011) compared baseline LEMS to nearly 1-year post-injury LEMS and found that only 2.9% of individuals with upper thoracic (T2-T5) SCI had a change in LEMS, and it was very small. In contrast, 40% of individuals in the low thoracic (T10-T12) group had a change of approximately 5 points in the LEMS (Zariffa et al., 2011). Overall, in complete paraplegia, the likelihood of a change in motor level occurs most in lumbar injuries, followed by low thoracic, with upper thoracic having the least likelihood of motor recovery (Kirshblum et al., 2021; Aimetti et al., 2019; Zariffa et al., 2011).

In relation to AIS, although there is much variability in this population, motor recovery is greater for individuals with an AIS B injury classification than for those with an AIS A classification, and greater in individuals with AIS C than in those with motor-complete injuries (Kirshblum et al., 2021; Marino et al., 1999, 2011). For individuals with AIS B tetraplegia, 2 studies examined results from large multicenter trials showing that the mean increase in motor scores from baseline to 6 months was 31.7 (Coleman et al., 2004; Fawcett et al., 2007) and an additional 6 points at 1 year (Fawcett et al., 2007). An older study compiling data from the SCI Model Systems Database with a sample of over 3,500 individuals with SCI showed similar results, with a mean increase of 28 points 1 year after injury, although with a large amount of variability (Marino et al., 1999). Marino et al. (2011) found that when this result was broken down into UEMS and LEMS, there was a 13-point increase in UEMS and a nearly 18-point increase in LEMS from baseline to 1 year after SCI.

A variety of studies have reported on changes in motor scores for individuals with AIS B paraplegia. Kirshblum et al. (2021) compiled this literature and reported a range of change of 12.6 to 22.7 points in LEMS at 1 year after SCI. Some specific examples of these data include a mean increase in motor scores from a large multicenter trial of 18.9 points at 6 months and 22.7 points at 1 year (Coleman et al., 2004; Fawcett et al., 2007). For motor-incomplete SCI, in a study that included over 1,400 individuals with tetraplegia, those with AIS C tetraplegia had a mean change in UEMS of 22.6 points and in LEMS of 23.3 points from baseline to 1 year after injury (Marino et al., 2011). In the same study, the authors analyzed the final UEMS and found a mean UEMS of 35 points and a mean LEMS of 38 points in AIS C. Individuals with AIS D injury classification had less of a change in motor scores from baseline to 1 year, although their scores at 1 year averaged 44 for UEMS and 45 for LEMS (Marino et al., 2011). Additional studies have reported on changes in motor scores for individuals with AIS C or D paraplegia, and Kirshblum et al. (2021) compiled this literature and reported a range of change of 934 points in LEMS measured at 6 months to 1 year. For specific information linking motor recovery and the ZPP, sensation, and age, see the subsection below titled ZPP and Neurological Recovery, as well as Sections 2.7 (Walking) and 2.8 (Arm and Hand Function).

Table 3 describes the available movements, mobility and activities of daily living, and equipment needs for individuals with AIS A and AIS B grade SCI at each neurological level of injury. For individuals with AIS C and AIS D grade SCI, these outcomes and expectations vary widely based on what muscles are under volitional control and the amount of volitional control the individual is capable of producing.

Table 3. Functional Expectations and Equipment Needs for Individuals With AIS A or B Grade SCI by Level of Injury*

Most Distal Nerve Root Segments Innervated	Key Muscles and Available Movements	Mobility Expectations	ADL Expectations	Equipment Needs
C1, C2, C3, C4	KM: Face/neck muscles, cranial nerves, diaphragm (partial innervation at C3 and C4) A: Talking, mastication, sipping, blowing, (scapular elevation C3-C4)	Bed mobility: Dependent Transfers: Dependent, Aides use mechanical lift Wheelchair mobility: Power: Independent with appropriate adaptive controls Manual: Unable Pressure redistribution: Dependent with positioning, use of tilt in space Standing: Dependent with tilt table Ambulation: Unable	Feeding: Dependent Grooming: Dependent Dressing: Dependent Bathing: Dependent Bowel and bladder: Dependent Home management: Dependent (may have modified independence with voice activated technologies) Driving: Unable Independently directs care when assistance is needed	Power-adjustable bed with pressure-reducing mattress Mechanical lift Power wheelchair with solid back, cushion, head support. Power seating (tilt and/or recline and/or legs), power seat elevator. Value added: Power standing Power wheelchair controls: adaptive head, chin, tongue, or sip-and-puff controls Portable ventilator, suctioning equipment Hand splints Tilt-in-space shower/commode chair Access technologies for communication and environmental interaction Accessible van
C5	KM: Biceps, brachialis, brachioradialis, deltoid, infraspinatus, rhomboid (major/minor), supinator A: Elbow flexion and supination, shoulder external rotation, shoulder abduction and flexion to 90°	Bed mobility: Assistance to dependent Transfers: If dependent, use mechanical lift; may be able to use transfer board with assistance Wheelchair mobility: Power: Independent (need U-shaped joystick) Manual: Independent to some assistance on level surfaces; assistance for outdoors Pressure redistribution: Independent in power wheelchair Standing: Dependent: tilt table or standing frame Ambulation: Unable	Feeding: Some assistance/ setup Grooming: Some assistance/ setup Dressing: Some assistance/ setup Bathing: Some assistance/ setup Bowel and bladder: Dependent Home management: Some assistance/setup Driving: May be independent with van with adaptive controls Independently directs care when assistance is needed	Power-adjustable bed with pressure-reducing mattress, bedrails, and loops Mechanical lift Transfer board Power wheelchair with solid back, cushion, head support, power seating (tilt and/or recline and/or legs), power seat elevator. Value added: Power standing Power wheelchair controls: joystick Manual wheelchair with cushion and assistive propulsion system (e.g., power-assist wheels) or rims/extensions Adapted utensils and splinting Mobile arm supports, deltoid aid Adapted bathing equipment Hand splints Shower/commode chair Access technologies for communication and environmental interaction Accessible van with adaptive controls
C6	KM: Extensor carpi radialis, infraspinatus, latissimus dorsi, pectoral major (clavicular portion), pronator teres, serratus anterior, teres minor A: Shoulder flexion, extension, internal rotation, and adduction; scapular abduction, protraction, and upward rotation; forearm pronation; wrist extension (tenodesis grasp)	Bed mobility: Independent to some assistance Transfers: Independent to some assistance for level; assistance needed for uneven surfaces Wheelchair mobility: Power: Independent for community (need U-shaped joystick) Manual: Independent to some assistance on level surfaces; some assistance for outdoors Pressure redistribution: Independent Standing: Tilt table or standing frame Ambulation: Unable	Feeding: Assistance to independent with setup or equipment Grooming: Assistance to independent with setup or equipment Dressing: Assistance to independent with setup or equipment, assistance for LE dressing Bathing: Assistance to independent with setup or equipment Bowel and bladder: Assistance typically needed; may be independent with adaptive equipment Home management: Assistance, may be independent with light household tasks and adaptive equipment Driving: Independent with van with adaptive controls Independently directs care when assistance is needed	Power-adjustable bed with pressure-reducing mattress, bedrails, and loops Transfer board Power wheelchair for community with solid back, cushion, head support, power seating (tilt and/or recline and/or legs), power seat elevator. Value added: Power standing Manual wheelchair with coated rims/ extensions, power assist wheel option Wheelchair cushion Universal cuff and adaptive utensils for feeding/grooming Adaptive equipment for dressing, bathing Hand splints Shower/commode chair Access technologies for communication and environmental interaction Accessible van with adaptive controls
C7	KM: Extensor pollicis longus and brevis, extrinsic finger extensors, flexor carpi radialis, triceps A: Elbow extension, wrist flexion, finger extension	Bed mobility: Independent with adaptive equipment Transfers: Independent, may need assistance on uneven surfaces Wheelchair mobility: Manual: Independent in home and community; may need assistance with ramps, curbs, uneven surfaces Pressure redistribution: Independent Standing: Standing frame Ambulation: Unable	Feeding: Independent with adaptive equipment Grooming: Independent with adaptive equipment Dressing: Independent with adaptive equipment Bathing: Independent with adaptive equipment Bowel and bladder: Independent with adaptive equipment Home management: Assistance for heavy household tasks Driving: Independent with adaptive controls	Manual wheelchair with coated rims. Option: solid back Wheelchair cushion ADL adaptive equipment Hand splints Shower/commode chair Access technologies for communication and environmental interaction Van/car with adaptive controls
C8	KM: Extrinsic finger flexors, flexor carpi ulnaris, flexor pollicus longus and brevis, intrinsic finger flexors A: Finger flexion	Bed mobility: Independent Transfers: Independent, may need assistance on uneven surfaces; may be able to do floor transfers Wheelchair mobility: independent in home and community, less assistance needed with ramps, curbs, uneven surfaces than in C7 Pressure redistribution: Independent Standing: Standing frame Ambulation: Unable	Feeding: Independent with adaptive equipment Grooming: Independent with adaptive equipment Dressing: Independent with adaptive equipment Bathing: Independent with adaptive equipment Bowel and bladder: Independent with adaptive equipment Home management: Assistance for heavy household tasks Driving: Independent with adaptive controls	Bedrails and loops if needed Transfer board for uneven surfaces Manual wheelchair with coated rims or assistive propulsion systems (e.g., power-assist wheels). Option: solid back Wheelchair cushion ADL adaptive equipment Hand splints Shower/commode chair Van/car with adaptive controls Less need for adaptive equipment due to increased hand function compared with that in C7. Value added: Access technologies for communication and environmental interaction

T1–T12	KM: Intercostals, long muscles of back (sacrospinalis and semispinalis), abdominal muscles (T7 and below) A: Improved trunk control with more caudal SCI, increased respiratory reserve, pectoral girdle stabilization for lifting objects	Bed mobility: Independent Transfers: Independent, including floor transfers Wheelchair mobility: Independent in home and community with manual wheelchair, including ramps, curbs, uneven surfaces Pressure redistribution: Independent Standing: Independent standing with assistive device and orthotics Ambulation: Independent to some assistance for household distances with assistive device and orthotics More caudal thoracic injuries will need less assistance for ambulation	Feeding: Independent Grooming: Independent Dressing: Independent Bathing: Independent Bowel and bladder: Independent with adaptive equipment Home management: Assistance for heavy household tasks Driving: Independent with adaptive controls	Manual wheelchair, lightweight Wheelchair cushion Assistive device for ambulation Walker or loftstrands Orthotics for ambulation: HKAFO, KAFO Adaptive equipment. Value added: Access technologies for communication and environmental interaction Shower/commode chair Vehicle with adaptive controls
L1, L2, L3	KM: Gracilis, iliopsoas, quadratus lumborum, rectus femoris, sartorius A: Hip flexion, hip adduction, knee extension	Bed mobility: Independent Transfers: Independent Wheelchair mobility: may use wheelchair for long distances Pressure redistribution: Independent Standing: Independent with assistive device and orthotics Ambulation: Independent with assistive device and orthotics	Feeding: Independent Grooming: Independent Dressing: Independent Bathing: Independent Bowel and bladder: Independent Home management: Independent Driving: Independent with adaptive controls	Manual wheelchair for community distances Wheelchair cushion Assistive device for ambulation (walker, forearm crutches, canes) Orthoses: HKAFO, KAFO, AFO depending on motor function
L4, L5, S1	KM: Quadriceps (L4), anterior tibialis (L5), hamstrings (L5–S1), gastrocnemius (S1), gluteus medius and maximus (L5–S1), extensor digitorum, posterior tibialis, peroneals, flexor digitorum (L5, S1) A: Strong hip flexion, strong knee extension, knee flexion, ankle dorsiflexion, ankle plantarflexion, ankle eversion, toe extension	Bed mobility: Independent Transfers: Independent Wheelchair mobility: May use wheelchair for long distances Pressure redistribution: Independent Standing: Independent with assistive device and orthotics Ambulation: Independent with assistive device and orthotics	Feeding: Independent Grooming: Independent Dressing: Independent Bathing: Independent Bowel and bladder: Independent Home management: Independent Driving: Independent with adaptive controls	Manual wheelchair for community distances Wheelchair cushion Assistive device for ambulation (loftstrands, canes) Orthoses: AFO, SMO, or foot orthotic insert

Abbreviations: A = available movements; DL = activities of daily living; AFO = ankle-foot orthoses; HKAFO = hip-knee-ankle-foot orthoses; KAFO = knee-ankle-foot orthoses; KM = key muscles; LE = lower extremity; SCI = spinal cord injury; SMO = supramalleolar orthosis .

*This table presents general functional expectations at various lesion levels for individuals with motor-complete SCI. Each progressively lower motor level includes the muscles from the previous levels. Although the key muscles listed frequently receive innervation from several spinal levels, they are listed here at the key neurological levels where they add to functional outcomes. Although intact musculature plays a main role in determining functional capability, many other factors influence function, including concomitant injuries, premorbid health status, age, body habitus, and psychosocial factors. Individuals with a motor-incomplete injury will likely have greater functional abilities.

Adapted from DeBlois A, Bowden M, Fulk GD. Traumatic spinal cord injury (Table 20.5). In: Fulk GD, Chui KK. *O'Sullivan and Schmitz's Physical Rehabilitation.* F. A. Davis Company; 2024, pp. 784-787.

SENSORY RECOVERY

Sensory Changes by Level and Severity of Injury. In individuals with compete SCI at baseline, the literature describes some improvements in sensory scores for PP and LT. However, fewer studies are related to sensory changes than to motor changes, results are variable, and the relationship to functional benefit has not been studied (Kirshblum et al., 2021). For individuals with tetraplegia, 2 studies summarized results from a large multicenter study and reported changes in sensory function from baseline (within 72 hours). At 6 months after injury, the average change was 13.8 points for LT and 8.3 points for PP, with negligible additional improvements at 1 year (approximately 112 points; Fawcett et al., 2007; Coleman et al., 2004). Similarly, in a study of 460 participants, of whom 91 had complete tetraplegia, the average improvement from baseline (1,530 days) to nearly 1 year after injury was 13 points for LT and 5.4 points for PP (Curt et al., 2008).

In individuals with complete paraplegia, multiple studies report that approximately 90% show no substantial change in sensory level from T2 to L1. Improvements that were observed occurred within 12 levels from the initial level (Zariffa et al., 2011; Lee et al., 2016; Harrop et al., 2011; Aimetti et al., 2019; Fawcett et al., 2007; Coleman et al., 2004). The neurological level of injury in those with paraplegia at initial assessment was demonstrated to stay at the same level in 35%-70% of cases, improve in 33%-40% of cases, and decline in 24%-32% of cases (Zariffa et al., 2011; Lee et al., 2016; Harrop et al., 2011; Aimetti et al., 2019). Zariffa et al. (2011) demonstrated that more improvement is observed in mid-thoracic injuries (T69-SCI) than in upper thoracic injuries (T25-SCI), although changes in both groups remained negligible.

Individuals with an initial SCI classification of AIS B tetraplegia demonstrate more improvements than do those with AIS A SCI (Kirshblum et al., 2021). From baseline to 6 months after injury, LT improved by 29.6 points and PP by 27.5 points in individuals with an initial classification of AIS B tetraplegia (Fawcett et al., 2007; Coleman et al., 2004). There was a negligible additional improvement of 3 to 4 points at 1 year (Fawcett et al., 2007). A different study done by Curt et al. (2008) showed more conservative improvements, with average increases of 10.2 for LT and 13.4 for PP, which highlights the variability in this population. By 6 months after injury, individuals with AIS B paraplegia demonstrate an average improvement of 17 points for both LT and PP scores. There are further improvements at 12 months to average scores of 23.2 for LT and 20.3 for PP (Fawcett et al., 2007; Coleman et al., 2004). The data from Curt et al. (2008) showed less robust changes in sensory scores for this population, with average improvements for LT of 3.6 and PP of 1.9 at 1 year.

Individuals with AIS C and AIS D tetraplegia and paraplegia show a wide variation in changes from 6 months to 1 year after SCI. For example, in individuals with AIS C or D tetraplegia, data from a multicenter study of over 700 participants indicated average score changes for LT and PP of 24.7 and 33.3, respectively (Coleman et al., 2004). However, in another large multicenter study of over 450 participants, the average change in LT and PP scores in individuals with AIS C and D was lower at 9.8 and 6.9 and 13.1 and 5.0 for LT and PP, respectively (Curt et al., 2008).

For individuals with AIS C and D paraplegia, average score changes at 6 months for one data set was 19.1 and 26.8 for LT and PP, respectively (Coleman et al., 2004), and 2 points or less for LT and PP at nearly 1 year after injury (Curt et al., 2008). Fifty-seven percent of individuals with AIS C and 63% with AIS D improved by 1 sensory level; 23.8% of AIS C and 19% AIS D did not change, and 19% of both declined 1 sensory level (Coleman et al., 2004; Curt et al., 2008).

Relationship Between PP Sensation and Motor Recovery. Preservation of PP sensation has been identified as a prognostic indicator; neurological recovery in a specific dermatome is associated with functional motor recovery in the corresponding myotome (Poynton et al., 1997). Specifically, in a sample of 59 participants with complete and incomplete SCI tested on admission, 85% of motor segments with a grade of zero in a specific dermatome but with sparing of PP sensation in that dermatome recovered to at least 3 out of 5. In comparison, only 1.3% in those segments without sparing of PP sensation recovered motor function to at least 3 out of 5 (Poynton et al., 1997). In individuals with complete thoracic SCI, PP or LT scores did not change significantly between discharge and approximately 1 year after injury. However, there was high variability in the magnitude of sensory changes, and most individuals

retained a neurological level of injury that was within 1 segment of the initial level after 1 year (Zariffa et al., 2011). Understanding sensory presentation in individuals with SCI can be helpful in determining prognosis for recovery, setting goals, establishing a plan of care, and managing expectations of the individual with SCI and their support persons. Additional information related to how sensory presentation translates to prognosis for recovery of ambulation can be found in Section 2.7 (Walking).

ZPP and Neurological Recovery. Early studies on recovery with sample sizes ranging from 60 to 150 have shown that individuals with complete tetraplegia who have a ZPP, i.e., some motor function preserved below the motor level, recover earlier and more often to motor grades 3 out of 5 or better compared with those who do not have motor preservation below the initial motor level (Ditunno et al., 1992). Specifically, in a sample of 150 participants with neurological levels of C4-C6, 90% of those who had some initial motor function in a ZPP improved to grade 3 out of 5 or better by 9-12 months after injury, whereas only 45% of those who had no initial motor function below their neurological level did so (Ditunno et al., 1992). A longer length of motor ZPP was associated with improvement in motor function at 2 or more levels in a sample of over 1,400 participants with tetraplegia classified as AIS A (Marino et al., 2011). ZPPs farther from the motor level have less likelihood of functional recovery, as concluded by Fisher et al. (2005) in a study of 70 participants with AIS A classification, for both tetraplegia and paraplegia.

Evidence from a sample of 399 participants with thoracic complete SCI suggests that a sensory ZPP does not predict changes in sensory levels or LEMS (Zariffa et al., 2011). However, a relationship was found between AIS conversion and individuals with AIS A who have a sensory ZPP that spans 3 or more segments. This baseline ZPP of 3 or more levels correlated to conversion to AIS B or higher by 48 weeks after injury. This correlation was stronger in individuals with a T6-T12 level of injury vs. T2-T5, where a significant correlation was not found (Zariffa et al., 2011). For individuals with T10-T12 injuries, the preservation of sensation of 3 or more segments below the neurological level increased the chance of conversion to motor-incomplete (Zariffa et al., 2011). Understanding these recovery patterns of the ZPP can be helpful in setting goals, establishing a plan of care, and managing expectations of the individual with SCI. It is important to note that earlier studies either used previous versions of AIS classification and ZPP definitions, which are not consistent with current updated ISNCSCI definitions (Kirshblum et al., 2020), or they discussed preservation of motor function in complete injuries without specifically stating or defining it as a ZPP.

Influence of Age at Injury on Neurological Outcomes. Age is a predictor of neurological outcomes after SCI, and it has been studied in a variety of contexts and functional outcomes. For information related specifically to recovery of ambulation, see Section 2.7 (Walking) in this CPG. A recent review of the literature on this topic concluded that, in general, younger age at the time of injury is a positive prognostic indicator for neurological recovery. However, study conclusions were inconsistent regarding age being a significant factor, as well as what age (e.g., 50 or 65 years) should be considered a cutoff for prognostic reference (Kirshblum et al., 2021).

Recommendations

1.1 We recommend that a thorough neurological examination be completed according to the International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) guidelines to determine a diagnosis. Progress should be monitored to ascertain neurological recovery or decline in order to understand potential outcomes and establish an optimal plan of care (1B).

1.2 We recommend examiner training to increase the accuracy of ISNCSCI assessment; training is available at the American Spinal Injury Association (ASIA) learning center (1C).

1.3 We recommend that algorithms be used ISNCSCI grading to improve accuracy of classification (1C).

1.4 We recommend that a baseline neurological assessment be obtained within 24 hours to 1 week after initial injury (1B).

1.5 We recommend that neurological status be reevaluated within the first year after spinal cord injury (SCI) and monitored throughout the life span as needed (1B).

1.6 We recommend that the neurological examination be used to guide clinical reasoning related to the prognosis of neurological recovery. We recognize that there is considerable variability in SCI presentation and that multiple factors beyond the ISNCSCI examination e.g., age, family support, education, socioeconomic status [SES]) should be considered in determining prognosis (1B).

1.7 We recommend that health care providers and scientists continue to evaluate emerging evidence related to neurological recovery after SCI, as there is ongoing research on additional factors that predict neurological recovery (1D).

Rationale

The synopsis of the evidence provides support for completing a neurological examination to help in clinical reasoning in order to establish a diagnosis and plan of care, as well as to assist in communication related to prognosis and recovery. Numerous factors influence recovery and provide some basis for establishing a prognosis. These factors include information related to the initial AIS classification, level of injury, motor presentation, sensory presentation, and age. Given the potential for change in some of these features, regular reexaminations are imperative in managing care for individuals with SCI (reviewed in Kirshblum et al., 2021). Clinicians can use the information obtained from the examination in their clinical reasoning to help determine the potential for improved functional outcomes, as described throughout this CPG. Research is ongoing to find additional ways to predict neurological recovery after SCI that will continue to help clinicians, researchers, and individuals with SCI better understand the prognosis for neurological recovery and outcomes (Scheuren et al., 2025).

Section 2: Functional Outcomes

2.1 Respiratory

Panel Findings

- Complications related to respiratory dysfunction are a leading cause of morbidity, mortality, and rehospitalization after SCI.
- The pathophysiology of respiratory dysfunction in SCI is multifactorial. The most common dysfunctions result from diaphragmatic weakness, accessory muscle weakness, impaired cough, decreased surfactant production, and impaired autonomic nervous system function, leading to relative parasympathetic dominance with increased secretions and bronchospasm. In general, the higher the SCI, the greater the impairment to respiratory muscles.
- Respiratory outcomes after SCI include both functional outcomes and complication rate outcomes over the life span. Respiratory system complications are consistently among the 3 most common health conditions associated with rehospitalization in the first 12 months after injury. Although patients are most vulnerable to respiratory illness in the first year after injury, respiratory complications continue over the life span.
- Clinical pathways with a structured respiratory protocol that includes a combination of evidence-supported treatment techniques provided regularly to individuals with SCI is effective in reducing respiratory complications and cost.

Synopsis of Evidence

Respiratory dysfunction-related complications are a leading cause of morbidity, mortality, and rehospitalization after SCI (Savic et al., 2017; van den Berg et al., 2010; Waddimba et al., 2009). In the acute hospitalization phase, respiratory complications are prevalent, affecting 84% of individuals with C1 to C4 SCI. Atelectasis (36.4%), pneumonia (31.4%), and ventilatory failure (22.6%) are the most common respiratory issues for this group during the acute phase (Jackson and Groomes, 1994). The literature suggests that the number of respiratory complications experienced during the initial acute-care hospitalization for cervical SCIs can be a more important determinant of length of stay and hospital costs than level of injury (Winslow et al., 2002). In a prospective assessment of mortality in chronic SCI, Garshick et al. (2005) noted that the most common causes of death in the first year and thereafter were pneumonia and other respiratory illnesses. A multicenter cohort study found that 16% of individuals with acute SCI experience at least 1 pneumonia event, with tetraplegia, traumatic etiology, and greater injury severity being associated with increased greater risk of pneumonia (Mueller et al., 2024). A systematic literature review on survival analysis following SCI worldwide reported that causes of death stem from secondary complications, with failure of the respiratory system being the leading cause (van den Berg et al., 2010)

In general, the higher the neurological level of injury, the greater the impairment to the respiratory musculature and associated complications (see Table 4). The most accurate way to determine the neurological level of injury and the resultant impairments that affect respiration in individuals with SCI is by performing the ISNCSCI examination. Muscles involved in respiration include the diaphragm, intercostals, abdominal muscles, and accessory muscles (sternocleidomastoid, scalenes, and trapezius). Impaired control of the autonomic nervous system also affects respiratory function after SCI due to parasympathetic dominance, with a resultant increase in mucus secretion and airway hyperactivity, particularly in individuals with higher thoracic and cervical injuries. The greatest determinant of respiratory failure necessitating intubation after acute SCI is the level and severity of injury relative to the phrenic nucleus at C3-C5, which innervates the diaphragm.

SCI at most levels affects innervation of the abdominal muscles. This severely compromises the ability to generate cough and clear respiratory secretions. Cough generation is accomplished by a large inspiratory volume followed by an expulsive expiration produced by the expiratory intercostal muscles and the abdominal muscles. An effective cough is an important defense mechanism to prevent respiratory tract infections and atelectasis. Forced expiratory volume

Table 4. Respiratory Function for Individuals With AIS A or B Grade SCI by Level of Injury

Level	Associated Muscles for Inspiration and Pulmonary Function	Associated Muscles for Expiration	Patient Outcomes
C1 C2	Sternocleidomastoid and accessory muscles (C1-C4)		Complete injury above C3 usually results in paralysis and denervation of all muscles required for inspiration and expiration. Life-long ventilation usually required.
C3	Diaphragm (C3-C8) Tidal volume is reduced from injury at or above this level.		
C4			An injury from C3-35 results in variable inability to inspire and expire. Often ventilated. May be able to wean from ventilation in time, depending on otherfactors.
C5		Pectoralis major muscle (CS-T1)	
C6 C7 CB	Scalenes accessory (C4-C8)		Patients experience more difficulty with expiration than inspiration. May not experience respiratory failure, but often experience muscle fatigue. Often ventilated initially but can usually achieve independent breathing.
T1 T2 T3 T4 T5	These muscles are responsible for producing vital capacity. Vital capacity reduced by up to S3%, peak expiratory flow rate reduced by up to 42%, and forced expiratory volume is reduced by as much as 49% compared to healthy individuals.	Internal intercostal muscles (T1-T11)	Patients experience more difficulty with expiration than inspiration. Patients experience a reduced ability to cough in an injury at or above this level.
T6 T7 T8 T9 T10 T11		Abdominal muscles and internal intercostals (T6-T12)	
T12			

Adapted from the Spinal Cord Injury Research Evidence (SCIRE) Professional acute respiratory management chapter (Vu et al., 2022). Available at https://www.scireproject.com/rehabilitation-evidence/respiratory-management-acute-phase

in 1 second (FEV1) and forced vital capacity (FVC) are usually measured in non-SCI individuals to detect airway obstruction. Because of the reduced inspiratory muscle force, these measures are diminished in individuals after SCI with higher lesions, especially in those with tetraplegia (Linn et al., 2000; Baydur et al., 2001). Peak expiratory force (PEF) may be more closely associated with coughing than FVC and FEV1 are. Thus, PEF has been suggested as a useful screening parameter in individuals with SCI in order to detect risk factors for respiratory complications early on (Mueller et al., 2012).

Postma et al. (2009) found that pulmonary function tests were a stronger predictor of respiratory infection in the first year following injury than were lesion level or completeness. Younger age and being male, heavier, and tall have been shown to be significant positive predictors of lung function parameters. Inspiratory muscle strength was positively predicted by younger age, being male, and being heavier, whereas expiratory muscle strength was positively predicted by younger age, being male, and greater time since injury (Mueller et al., 2012). However, these same relationships may not old true in persons with long-term SCI, in whom level of injury, sex, and weight were stronger predictors (Raab et al., 2019).

Evidence from specialized units dedicated to the care of those with SCI, as well as a case series study, shows that a progressive ventilator-free breathing protocol is more successful for weaning individuals with C3 and C4 SCIs than is intermittent mandatory ventilation (Peterson et al., 1994; Wong et al., 2012). The use of mechanical insufflation or exsufflation coupled with manual chest therapy kinesitherapy techniques for secretion mobilization is supported by randomized controlled trials (RCTs) (Pillastrini et al., 2008; Jeong and Yoo, 2015).

Respiratory muscle training improves respiratory muscle strength (Berlowitz and Tamplin, 2013; Shin et al., 2019) and decreases the number of respiratory infections (Ehrlich et al., 1999; Van Houtte et al., 2008) in individuals with cervical SCI. Inspiratory muscle training, specifically, has been shown to lead to a statistically significant improvement in respiratory function, including maximal inspiratory pressure (Postma et al., 2014; Berlowitz et al., 2013; West et al., 2014). The use of abdominal binders in individuals with tetraplegia significantly increases vital capacity and decreases functional residual capacity in all positions (Hart et al., 2005; Vu et al., 2022; Julia et al., 2011; Wadsworth et al., 2012). An adequate vital capacity is an essential element of an effective cough.

Dysphagia following cervical SCI can increase the risk for pulmonary complications (Shem et al., 2011). Early diagnosis of dysphagia is therefore important in the respiratory management of patients with acute cervical injuries. Estimates of the incidence of dysphagia in individuals with tetraplegia within 1 month of injury are as high as 40% (Shem et al., 2011). Complications resulting from dysphagia in SCI include transient hypoxemia, chemical pneumonitis, mechanical obstruction, atelectasis, bronchospasm, and pneumonia (Wong et al., 2012; Shem et al., 2011; Kirshblum et al., 1999). The Consortium for Spinal Cord Medicine (2005) has published recommendations for early assessment of dysphagia after acute SCI titled *Respiratory Management Following Spinal Cord Injury*. Breathing disorders, including sleep apnea, appear to have a higher prevalence in individuals after SCI than in those without SCI, with some researchers estimating that it is present in 60% of motor-complete individuals with tetraplegia (Proserpio et al., 2015; Chiodo et al., 2016).

Standardized assessment of respiratory function supports optimal treatment planning. Recommended measures include evaluation of respiratory muscle strength (maximal inspiratory pressure and maximal expiratory pressure), lung function (FVC), FEV1, PEF, and peak cough flow performed according to the American Thoracic Society (2025) guidelines.

Recommendations

2.1.1 We recommend evaluation of respiratory function in the acute phase, including functional assessment of respiratory muscles based on standardized measurement of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), or peak expiratory flow rate (especially during cough); negative inspiratory force, also known as maximal inspiratory pressure; respiratory complaints; physical examination of the respiratory system; chest imaging as indicated; pulse oximetry; accurate neurological level; and extent of injury (1B).

2.1.2 We recommend that respiratory management of individuals with SCI who are ventilated and those with the capacity to wean from ventilators be managed on the basis of published guidelines for aggressive acute injury assessment and management. Specifically, clinical pathways with a structured respiratory protocol that includes a combination of treatment techniques should be used to reduce respiratory complications and cost (1C).

2.1.3 We recommend when undertaking ventilator weaning in an individual with cervical SCI that management include use of a progressive ventilator-free breathing protocol regimen of relatively high-volume ventilation combined with medication optimization, noninvasive ventilation, and aggressive pulmonary secretion management (1D).

2.1.4 We recommend screening individuals with acute and chronic SCI for dysphagia and sleep-disordered breathing. Those with positive results should undergo more detailed assessment (1D).

2.1.5 We recommend that respiratory muscle training be encouraged for maintaining lung compliance and increasing chest expansion, strengthening inspiratory muscles to facilitate breathing with lower energy expenditure, and promoting prompt elimination of pulmonary secretions (1B).

Rationale

Respiratory outcomes after spinal cord injury include both functional outcomes and complication rate outcomes over the life span. Complications related to respiratory dysfunction are a leading cause of morbidity, mortality, and rehospitalization after spinal cord injury.

2.2 Bowel – Neurogenic Bowel Outcomes

Panel Findings

- Neurogenic bowel dysfunction (NBD) affects individuals with SCI in all aspects of physical and psychosocial health.
- The severity of NBD is related to the severity and level of the SCI. It is worse in individuals with more complete injuries and with higher level injuries.
- NBD is improved with early education and training of individuals with SCI and their caregivers for neurogenic bowel management and independence.
- Improved mobility with activities for ambulation and the wheelchair improve NBD.
- There are significant problems with constipation in individuals with SCI overall. NBD related to constipation is most severe in individuals with more complete injuries and higher level injuries. Constipation is associated with an increased need for medications and caregiver assistance.
- The occurrence of fecal incontinence is high in individuals with SCI in general. NBD related to fecal incontinence is is most severe in individuals with complete injuries, in individuals with decreased mobility, and in those with lower injuries and absent reflexes. It is largely associated with adequacy of bowel management.
- Quality of life (QOL) and social and daily activities of individuals with SCI is greatly affected by the severity of neurogenic bowel symptoms, including constipation, fecal incontinence, and abdominal symptoms.

Synopsis of Evidence

NBD in individuals with SCI can be characterized by the severity of constipation due to changes in colon motility, the occurrence of fecal incontinence due to loss of voluntary sphincter control, and other symptoms, including abdominal bloating and discomfort. The impact of NBD on individuals with SCI cannot be overemphasized. A survey by Wheeler (2018) indicated that for 78% of the responding participants with SCI, bowel problems were considered equally or more important than urinary incontinence. Among those who experienced a change in their bowel health in the preceding year, most (63%) described it as getting worse. Furthermore, it was determined that bowel incontinence, constipation, and other symptoms were important and persistent problems that can lead to hospitalizations. Fifty-six percent of the responding participants with SCI affirmed having been hospitalized at least once due to a bowel problem in the previous 12 months; 68% of those were emergency admissions. About half (54%) of those with bowel problems in this sample sought medical attention within a month of symptom onset, but 11% waited 6 months or more, and some may not have sought attention until hospitalized.

Influence of Level and Severity of Injury. The severity of SCI significantly predicts NBD and has a significant positive association with the severity

of NBD (Adriaansen et al., 2015, n=258). Both paraplegia (complete and incomplete) and incomplete tetraplegia are significantly associated with reduced bowel function in individuals with SCI (Tate et al., 2016, n=291). The risk of having a severe NBD was approximately 13 times greater in individuals with AIS A than in those with AIS D. In general, about 39.4% of individuals with SCI had a severe degree of NBD. In those with AIS A SCI, 71% were shown to have severe NBD, and about half with AIS D SCI had only a minor degree of NBD (Liu et al., 2009, n=128; Liu et al., 2010b, n=142).

NBD is more severe in individuals with higher levels of SCI: 35.2% were found to be in the severe range and 24.8% in the moderate range (Cameron et al., 2015, n=175). Individuals with cervical or thoracic SCI are more likely have severe NBD than are those with lumbar SCI. Furthermore, individuals who had SCI for over 10 years (53.3%) and who were over 65 years old (50%) were likewise found to have severe NBD (Liu et al., 2010b).

Constipation and Gastrointestinal Symptoms. In a study of 54 participants with SCI, 88% presented with bowel problems, 53% of which was constipation. In addition, constipation was found to occur more in SCI above T7 than below T7 (Valles et al., 2006, n=54). Factors that are associated with a lower likelihood of constipation include incomplete tetraplegia vs. complete tetraplegia, normal defecation, and less frequent bowel movements. Age and ethnicity influence the likelihood of experiencing constipation, as younger individuals and White individuals with SCI are less likely to have constipation than are older individuals and Black individuals with SCI. Conversely, having a history of bowel surgery; using laxatives, medications, or both as a main method of bowel management; receiving caregiver services; and experiencing more frequent abdominal pain were all associated with constipation (Tate et al., 2016).

Fecal Incontinence. In a study of 1,135 participants with SCI, 87% reported fecal incontinence (Lynch et al., 2000). In a study of 599 women with SCI, 35% reported experiencing fecal incontinence within the last 3 months, and 21% reported experiencing daily or monthly episodes of fecal incontinence. Fecal incontinence was positively associated with permanent use of a wheelchair compared with no walking aids, a more complete injury compared with an incomplete injury at any level, and older age (Elmelund et al., 2019). Fecal incontinence appears to be most associated with management (i.e., timing, having a spouse or significant other, and use of diuretics) and overall dysfunction. Conversely, the level of neurological impairment was not found to be significant for fecal incontinence (Tate et al., 2016).

Relationship Between NBD and Physical Functioning. Early admission to rehabilitation significantly predicts improvement in bowel scores at discharge, after adjusting for surgery time and injury severity (Attabib et al., 2021, n=92). Approximately 92% of individuals with SCI who have independent bowel management at initial assessment maintain independent bowel management after 1 year (Pavese et al., 2019, n=167). The total ISNCSCI motor score is a good predictor of independent bowel function at 1 year following SCI (Pavese et al., 2019, n=167; Khan et al., 2021, n=277).

Types of Management Methods Used. Methods of bowel management were evaluated in a few studies. Overall, conservative defecation methods were the most frequently used in the majority of the participants (Adriaansen et al., 2015; Coggrave et al., 2009). Coggrave and Norton (2010) found that up to 30 minutes was spent on each bowel care episode by 58% of the participants, 31-60 minutes by 22%, and over 60 minutes by 14%. Individuals reporting more bowel problems were likely to report a longer duration of bowel care and a greater number of interventions used. Social media, websites, and peer support groups are the main source of information for bowel management for those with NBD (66% collectively). A health care professional is the main source of information about NBD for only 26% of the respondents across groups, including SCI. A significant number of SCI respondents said they had tried over-the-counter medication (45%) and/or natural remedies (37%) for their bowel problems without consulting a health care professional (Wheeler, 2018).

The number of methods used for bowel management was examined in a study of 291 participants by Tate et al. (2016). On average, participants with SCI were found to primarily use 2 main methods. One method was used by 39.6% of the participants, 2 methods by 39.2%, 3 methods by 15.2%, 4 methods by 5.5%, and 5 methods by <1%. The most frequent main methods were digital stimulation (51.4%); laxatives, oral medications, or both (38.8%); digital evacuation (30.2%); suppositories (29.9%); straining or bearing down (15.8%); and enemas or mini-enemas (13.1%). All other methods were reported by <10% of the participants. In general, the usual combinations of methods were digital stimulation and digital evacuation (22.7%), digital stimulation and laxatives (18.9%), and digital stimulation and suppositories (17.9%), occasionally in combination with other methods. Similar findings were noted in another study of 68 participants that showed that rectal stimulants, often in combination with digital stimulation or manual evacuation, were used by the majority of participants (59.6%; Coggrave et al., 2009).

In another study, Adriaansen et al. (2015) showed digital evacuation to be the most commonly used intervention, with a lesser use of suppositories. The same study demonstrated that the use of suppositories and digital evacuation was a significant predictor of severe NBD. Transanal irrigation was used by only 11% of the participants, and only some participants (8%) had surgery for their bowel management: 3% colostomy, 3.5% sacral anterior root stimulation, and 1.9% ileostomy (Adriaansen et al., 2015). Transanal irrigation was shown by Christensen et al. (2006) to significantly reduce constipation and fecal incontinence in participants with SCI who were wheelchair users or who were confined to bed.

Correlation With Neurological Status. A predictive model based on data from 1,250 individuals with SCI was developed to forecast independent, reliable bowel management at one year after SCI. The total ISNCSCI motor score, measured within 40 days of injury, was the sole significant predictor and demonstrated high predictive accuracy (aROC = 0.837), which was confirmed in a prospective validation cohort (Pavese et al., 2019). The number of methods used for bowel management is related to injury level and severity; individuals with complete tetraplegia are more likely to use a combination of 3 methods and those with incomplete paraplegia are likely to use only 1 method (Tate et al., 2016). In a study of 291 individuals with SCI, digital stimulation was the most commonly reported method (51.4%), followed by laxatives and/or oral medications (38.8%), digital evacuation (30.2%), suppositories (29.9%), straining/bearing down (15.8%), and enema or mini-enema (13.1%). All other methods were reported as <10%. When the level of injury is considered, straining or bearing down was used by 34.7% of those with lower motor neuron (LMN) bowel and 11.7% of those with upper motor neuron (UMN) bowel, and suppositories were used by 34.2% of those with UMN bowel and 10.2% of those with LMN bowel (Tate et al., 2016). A sytematic review that included 54 studies showed that participants with UMN bowel usually use suppositories and/or digital stimulation (Krassioukov et al., 2010). NBD was found to be less severe for those who used laxatives or oral medications as a main method of bowel management (Tate et al., 2016).

QOL, Social and Daily Activities. The QOL and physical functioning of individuals with SCIs is affected by the severity of bowel symptoms, and limitations imposed by the need for bowel care is reported to have a negative impact on QOL. Bowel symptoms, including fecal urgency, incontinence, and constipation, were identified as the most troubling in SCI (Stoffel et al., 2018). In a large survey by Coggrave et al. (2009, n=1,334), approximately 21% of participants with SCI reported having to fit their life around their bowel program, 8% reported that it restricts relationships and stops them from working, 16% identified it as a problem, 10% reported that it affects their social life, and 17% reported that it inhibited them from staying away from home.

Lynch et al. (2000, n=467 SCI, 668 control) identified that incontinence was more likely to affect the life of individuals with SCI if they had a complete injury. They also reported that the higher the level of injury (incomplete and complete), the more often assistance is required. In another survey with 287 participants, 70% reported their social life to be affected by bowel care, 62% were prohibited from staying out of the home, 41% were prevented from working away from home, and 60% reported that it affected personal relationships. Those with a lower level of SCI reported an increased frequency of fecal incontinence (Inksip et al., 2018). A prospective study by Faaborg et al. (2008, n=159) found that social life and QOL were restricted by colorectal dysfunction and difficulties in evacuation, but not by fecal incontinence or constipation. Data from 370 veterans concluded that both those who had

a colostomy and those who used a conservative bowel management program were equally unsatisfied with their bowel care (Luther et al., 2005).

Satisfaction with bowel care programs is reported to increase SCI QOL, specifically in the subgroups of work and social function, bowel issues, and symptoms (Pardee et al., 2012, n=241). With the presence of constipation, urinary tract infections (UTIs), or bowel incontinence, individuals with SCI are likely to not participate in certain daily activities. Cobb et al. (2014, n=1,137) found that 54% (14 of 26) of daily activities were significantly affected in the presence of constipation and 27% in bowel incontinence. Those with bowel incontinence were reported to be 1.8 times more likely to be unemployed (Franceschini et al., 2012, n=403). Abdominal pain and fecal incontinence are significantly associated with higher anxiety. Fecal incontinence is associated with higher depression scores, and abdominal pain showed a trend toward an association with depression (Ng et al., 2005).

Recommendations

2.2.1 We recommend that health care providers, individuals with SCI, and caregivers be aware that neurogenic bowel dysfunction (NBD) affects individuals with SCI physically, functionally, and psychosocially and that this affects overall health (1B).

2.2.2 We recommend the evaluation and implementation of an appropriate bowel management plan, with regular monitoring of NBD, to maintain health, improve quality of life (QOL), and facilitate participation in social and daily activities (1C).

2.2.3 We recommend ongoing education and adequate training of health care providers, individuals with SCI, and caregivers for the evaluation and management of NBD to facilitate appropriate bowel management that will prevent bowel complications over the life span of the individual with SCI (1D).

2.2.4 We recommend that individuals with SCI be engaged in discussions about their health beliefs, behaviors, and preferences to be able to successfully treat NBD, minimize complications, and improve QOL and outcomes of NBD (1D).

Rationale

Individuals with SCI are significantly affected by neurogenic bowel in all aspects of their lives. Those whose injuries are more severe and those with higher levels of SCI experience a greater effect of NBD. Because the complicated gastrointestinal tract is intimately related to the most basic of functions such as eating, digestion, and evacuation of waste, the neurogenic bowel is challenging to manage routinely. The altered gastrointestinal function must be treated on a regular consistent basis, which entails adherence and a high level of self-management to prevent complications. Taking on this responsibility and commitment requires appropriate and adequate education, instruction, and understanding of pathophysiology and options for management. Essential goals for neurogenic bowel management include complete emptying of stool on a regular basis; prevention of constipation, fecal incontinence, and gastrointestinal symptoms; and maintenance of good nutrition. Treatment methods can be difficult and the medical provider and the individual with SCI must partner in formulating a bowel plan that can be successfully completed daily or 3-4 times weekly. It is crucial that individuals with SCI take charge of and participate in decision making and formulating an effective plan, not only to keep themselves free of complications, but also to maintain a good QOL and their well-being.

2.3. Bladder – Neurogenic Bladder Outcomes

Panel Findings

- SCI affects the ability to voluntarily void urine, those with more severe injuries having the least ability to void volitionally.
- Greater independence in bladder management is associated with less severity and lower levels of SCI.
- Individuals with SCI who have lumbar and sacral sensation, and those who have higher lower extremity motor scores, are likely to have greater ability to void volitionally.
- UTIs are more frequent in individuals with more severe and higher levels of SCI.
- Neurogenic bladder complications are high in individuals with SCI and include recurrent UTIs, bladder calculi (stones), vesicoureteral reflux, hydronephrosis, upper urinary tract deterioration, and renal compromise.
- Indwelling catheters are highly associated with neurogenic bladder complications, including emergency department visits and hospitalizations, and with increased mortality rates.
- QOL and satisfaction are better with the use of an indwelling catheter and surgical management of neurogenic bladder; however, the risks related to these methods of management must be considered.
- QOL and satisfaction are negatively affected by UTIs, bladder symptoms, and bowel dysfunction.
- Intermittent catheterization has the advantage of better preservation of bladder function, but the disadvantages of being unfavorable and inconvenient. Indwelling catheters have the advantage of being favorable and convenient, but the disadvantage of causing bladder complications.

Synopsis of Evidence

SCI often results in loss of voluntary control of urinary voiding, with the amount of loss related to the severity and level of the injury. Detrusor overactivity coupled with detrusor sphincter dyssynergia occurs in supra-conal lesions, and detrusor hypoactivity occurs in infra-conal lesions. Poor bladder emptying leads to high urine residual volumes and bladder hypertrophy, which can lead to high intravesical pressures affecting the upper urinary tract and can cause life-threatening renal failure (Cruz and Cruz, 2011). In a large SCI cohort of 1,479 participants, the most common bladder management approaches were clean intermittent catheterization (51%), indwelling catheter (18%), surgery (13%), and volitional voiding (18%) (Myers et al., 2019b).

Severity of Injury: A number of studies have examined the influence of severity of SCI on volitional voiding ability, with the voluntary ability to void most likely to be retained in those with less severe injuries. Voluntary voiding was significantly more likely in individuals with AIS D than in those with AIS A-C (tetraplegia and paraplegia) injury severity (Jorgensen et al., 2017a, n=123). Similarly, a study based on a national data set in the United States reported greater rates pf volitional voiding with less severe injury classifications (AIS A = 1.4%, B = 4.5%, C = 27.7%, D = 74.4%; Zlatev et al., 2018, n=4481). These trends continue at 1-year follow-up, wherein the rate of volitional voiding is 5.1% in individuals with AIS A injury classification vs. 76.2% in AIS D. Those with AIS C injury classification had lower rates of volitional voiding than did those with AIS D (Elliott et al., 2018, n=4,915).

A full predictive model that includes LEMS, sensory level, sacral sparing, sex, and age showed a lower voluntary voiding ability with greater injury severity (Elliott et al., 2018, n=4,915). Preservation of lumbar and sacral sensation is associated with a significantly greater ability to volitionally void at 1 year after injury and later. Younger age, greater preservation of motor and sensory function, higher LEMS, and female sex are associated with a higher likelihood of voiding voluntarily 1 year after SCI (Elliott et al., 2018, n=4,915). Likewise, greater preservation of sensation at S3-S5 is associated with a significantly higher likelihood of maintaining the capability to volitionally void (Alexander et al., 2017, n=79). Smaller studies have confirmed that LEMS, sphincter function, and LT sensation at S3 predict bladder function, urinary incontinence, and bladder emptying (Scivoletto et al., 2018, n=85; Pavese et al., 2016, n=125).

Level of Injury. A study of 1,479 participants evaluated bladder management approaches, finding that participants with paraplegia used clean intermittent catheterization at higher rates than did those with tetraplegia (62% vs. 36%, respectively); those with paraplegia were less likely to use an indwelling catheter than were those with tetraplegia (10% vs. 30%, respectively). The indwelling catheter and surgery groups had more favorable neurogenic bladder severity ratings, whereas the voiding group had less favorable scores than the intermittent catheterization group for both individuals with tetraplegia and paraplegia. In participants with paraplegia, bladder dysfunction severity ratings were more favorable for those who were older and male, but with a greater likelihood of UTIs (1-3 and 4 or more per year, respectively). In participants with tetraplegia, bladder dysfunction was less severe in men and more severe in participants with obesity and with UTIs (Myers et al., 2019b). Dengler et al. (2021, n=299) reported greater independence in bladder management in individuals with C6 motor-incomplete SCI (some control of lower extremities) (n=204). Individuals with SCI with LOI of C8 motor-incomplete and strength of 3-5 out of 5 for finger flexion had functional independence in bladder management.

Neurogenic Bladder Complications. Neurogenic bladder complications consist of bladder and kidney UTIs, upper urinary tract deterioration (hydronephrosis or dilatation), vesical and renal calculi, urethral damage, renal failure, and other infections of the genitourinary system. The literature describes outcomes related to neurogenic bladder complications. El-Masri et al. (2012) determined that the total complication rate at all stages of SCI (acute, subacute, chronic) was 62%. Complications of the upper urinary tract accounted for 22.6% of all complications (El-Masri et al., 2012, n=119).

UTIs are significantly associated with injury level (Stillman et al., 2017, n=169). The cumulative incidence of UTI decreases with decreased injury severity (95% in AIS A-C vs. 24% in AIS D). Participants' subjective assessment of UTI frequency is highest among those who use indwelling catheters, followed by clean intermittent catheterization, and then pads or condom, and lowest with spontaneous voiding. The odds of hospitalization for UTI were 3 times higher for users of indwelling catheters than for those who were able to void volitionally (Roth et al., 2019). Manack et al. (2011) surveyed a large sample of individuals with neurogenic bladder, of whom 4,168 had SCI. They found high rates of UTIs of 29%-36% among participants. Obstructive uropathies (6%-11%) and urinary retention (9%-14%) were likewise observed. Within 1 year, 33.3% were hospitalized, and 14.4% were in a nursing home. UTI diagnoses comprised over 20% of all hospitalizations 1 year after index (Manack et al., 2011). In addition, aside from UTIs, higher injury level and complete SCI were reported to be associated with worse stone clearance and more complications (the rate of having no calculi was 17%). Individuals with SCI who had neurogenic bladder averaged 16 office and 0.5 emergency department visits annually.

In a study of participants with neurogenic bladder complications due to SCI, anatomical lower urinary system pathologies were present in approximately 50% (Çetinel et al., 2017, n=303). Urodynamic findings most often showed detrusor overactivity with dyssynergia (38%). Vesicoureteral reflux was evident in approximately 15% of participants with SCI and upper urinary tract deterioration in approximately 32%. These participants were found to have abnormal radiological lower urinary tract findings, the absence of antimuscarinic drug use in their history, high detrusor pressure (>75 cmH2O), and low bladder capacity (Çetinel et al., 2017). Individuals with SCI who had vesicoureteral reflux were shown to have a higher risk of pyelonephritis (Ku et al., 2005, n=179). Upper tract deterioration was more common among indwelling urethral catheter users than among those using other methods (Çetinel et al., 2017; Ku et al., 2005). Indwelling catheter time, interval since injury, voiding status, lower urinary tract pathologies, detrusor pressure, and bladder capacity were demonstrated to be essential factors affecting upper urinary tract deterioration in those with SCI (Çetinel et al., 2017). Weld et al. (2000, n=308) demonstrated a significant association of Foley catheterization with upper tract abnormalities, as well as renal compromise associated with elevated serum creatinine levels, decreased creatinine clearance, and occurrence of proteinuria. Mortality due to all causes was higher in users of Foley catheters. Three participants who needed renal replacement therapy for end-stage renal disease were managed with Foley catheterization.

Studies have suggested that genitourinary diseases (such as UTIs) are the most common cause of rehospitalization in individuals with SCI and that these diseases are most common in individuals with AIS A-C injury classification (Cardenas et al., 2004b). Indwelling catheter users have been reported to have the greatest risk of having a hospitalization or emergency department episode for a urological indication, followed by clean intermittent catheterization users, compared with those who void spontaneously (Crescenze et al., 2021). There was a high incidence of hospitalizations or emergency department visits for individuals with SCI during a 1-year follow-up, and urological complications were the most common reason for admission. Moreover, in a large cohort of 8,206 participants with SCI, drainage techniques, such as an indwelling catheter, increased the odds of mortality compared with those of other techniques (Shavelle et al., 2015, n=8,206).

In a study of 43 participants who were followed for 40-50 years after SCI, recurrent UTIs were noted in all participants, with an average incidence of 6.1 cases per 5 years per person. The incidence of UTIs peaked in the first and tenth 5-year intervals. Besides UTIs, the most common complications were bladder stone (49%), hydronephrosis (47%), and vesicoureteral reflux (33%). Most complications initially occurred during the first 25 years after injury. Male sex, cervical injury, and condom catheter use were closely related to complications, in particular UTIs and renal deterioration. The type of bladder management used for the longest period were condom catheters in men (79%) and clean intermittent catheterization in women (33%), with an average maintenance of 23.6 and 38.0 years, respectively (Gao et al., 2017).

QOL, Social and Daily Activities. Outcomes for QOL and satisfaction and for social and daily activities in individuals with SCI with neurogenic bladder mainly revolve around the method of management, control of symptoms, and occurrence of complications. Welk et al. (2021) evaluated 1,479 participants with SCI and determined that most bladder-related psychosocial priorities were not affected by age, sex, or level of SCI. They observed that differences in psychosocial priorities for the method of bladder management (i.e., between indwelling and intermittent catheter use) represent factors that should be considered. Two larger studies found that only 21% of participants with SCI void without specific bladder management strategies, that higher frequency of incontinence was associated with the lower QOL ratings, and that clean intermittent catheterization was consistently rated as less satisfactory than indwelling catheters or surgery as management strategies (Liu et al., 2010a, n=142; Myers et al., 2019b, n=1,479). The SCI-QoL Difficulties scores were better (lower) for surgery in the paraplegia group. In the tetraplegia group, the SCI-QoL Difficulties scores were better for indwelling catheter and surgery and worse for voiding (Myers et al., 2019b).

A study of the time burden associated with bladder management found that longer catheterization times are required for individuals with cervical SCI (mean 12.4 minutes per catheterization) and for women who require caregiver assistance (mean 20 minutes per catheterization) (Velaer et al., 2021, n=87). In addition, obese or overweight women had longer clean intermittent catheterization times than did normal-weight women (14.5 minutes vs. 7 minutes, respectively), whereas catheterization time was similar for all men regardless of body mass index (BMI). Participants with indwelling catheters spent less than one-third of the time on bladder management per day spent by those who used clean intermittent catheterization (17 vs. 53 minutes per day, respectively). Another study showed that the rates of dissatisfaction and decreased QOL with clean intermittent catheterization declined with the passage of time; however, women continued to be highly dissatisfied with the burden of clean intermittent catheterization (Crescenze et al., 2019). Participants with augmentation cystoplasty (i.e., bladder autmentation) who used clean intermittent catheterization were found to have better urinary function and satisfaction with their urinary symptoms than those who performed clean intermittent catheterization with or without botulinum toxin treatment (Myers et al., 2019a, n=879).

Physical disability does not predict dissatisfaction with urinary QOL, but severe bowel dysfunction and recurrent UTIs were found to have a significant negative impact (Crescenze et al., 2019, n=1,479). In a cohort of 338 participants with SCI, approximately 46% reported 13 UTIs per year, 15% reported 46 UTIs per year, and 13% reported >6 UTIs per year. Higher UTI rates were independently associated with worse QOL. Compared with those with no UTIs or fewer UTIs, participants who reported >6 UTIs per year were more likely to limit daily activities, experience increased muscle spasms, perceive that a UTI would not go away, and avoid going out because of UTIs (Theisen et al., 2020). A large study that evaluated psychosocial QOL and bladder-related QOL in 1,479 participants with SCI demonstrated an association between psychosocial health-related QOL and bladder-related QOL outcomes. Worse bladder-related outcomes were associated with a higher pain rating, whereas better bladder-related outcomes were associated with higher ratings of independence and positive affect (Moghalu et al., 2021).

Recommendations

2.3.1 We recommend the regular monitoring of neurogenic bladder and its sequelae, as implementation of appropriate bladder management is crucial in maintaining bladder health and overall health (1B).

2.3.2 We recommend that prevention of bladder complications (e.g., urinary tract infections [UTI], vesicoureteral reflux, upper tract deterioration) be prioritized to prevent morbidity and mortality in individuals with SCI (1B).

2.3.3 We recommend that individuals with SCI be involved in the decision making and selection of the preferred method of bladder management, not only to preserve QOL and satisfaction, but also to prevent neurogenic bladder complications (1C).

Rationale

The severity of neurogenic bladder is largely dependent on the severity and level of SCI, which likewise affects function and self-management. The primary goal of treatment of the neurogenic bladder is to preserve bladder and upper urinary tract health to prevent complications that can lead to morbidity and mortality. First-line clinical recommendations for treatment, such as intermittent catheterization, can be cumbersome and often affect the QOL and psychological well-being of the individual with SCI. Providing the individual with SCI with adequate knowledge and understanding of neurogenic bladder pathophysiology, sequelae, and therapeutic aims can facilitate self-determined choices for care according to preferences, resources, daily routine, etc. Medical providers must understand that it will be necessary to provide guidance in balancing these decisions and keeping individuals with SCI with neurogenic bladder as healthy and free from problems as best as possible (i.e., using an indwelling catheter vs. increased risk of UTIs and upper tract deterioration).

2.4 Sexual Health

Panel Findings

- Sexual health is a high priority for individuals with SCI.
- Because SCI often decreases community participation and social engagement, individuals with SCI may have a harder time finding romantic or sexual partners.
- Individuals with SCI often have to confront significant misinformation about their ability to have sex or become parents.
- Individuals with SCI have higher rates of sexual dysfunction than the general population does, including problems with arousal, ejaculation, and orgasm, which appear to be related to the level and severity of SCI. Treatments are available for sexual dysfunction that appear to enhance outcomes.
- SCI does not make women infertile; however, in men, fertility is reduced and conceiving may require assistance. Individuals with SCI can still have children and should use contraception if engaging in sexual activity when pregnancy is not a desired outcome.
- SCI increases the risk of complications during pregnancy, as well as during and after delivery for women.

Synopsis of Evidence

Research shows that sexual health is a top life priority for many individuals with SCI (Anderson et al., 2004; Simpson et al., 2012), that SCI often alters an individual's sense of self, and that many individuals with SCI believe that improving sexual function would improve their QOL (Anderson et al., 2007). Individuals with SCI report engaging in sexual activity less frequently than do age-matched controls without SCI (Kreuter et al., 1996, n=252 with SCI, 264 age- and sex-matched controls); however, the majority of adults with SCI (61%) report being satisfied with their sex life (Kreuter et al., 1996, n=252). Moreover, increased time since injury appears to result in an increased frequency of women engaging in sexual intercourse (Jackson and Wadley, 1999, n=472 women with SCI). Despite its importance to people with SCI, sexual function assessments are often often omitted. In Swiss study of data sets (n=1126) obtained during inpatient SCI rehabilitation, 46% lacked sexual function data. Records for women were less likely to have completed sexual function data compared to men (43% vs 58%) (Anderson et al., 2026).

Sex-Specific Findings

Men with SCI

SCI increases the risk and rates of sexual dysfunction in men, with higher rates among those with a higher level and greater severity of impairment and, inconsistently, among older men. The length of time after injury is positively related to having experienced orgasm (Anderson et al., 2007, n=199 men with SCI), and men with SCI who report ejaculation are significantly younger (mean 46 years vs. 54 years) than those who report inability to ejaculate ($p<0.0001$; Biering-Sorenson et al., 2012, n=279). Individuals with more severe SCI appear to have higher rates of anejaculation and more difficulty achieving orgasm than do those with less severe injuries (Chehensse et al., 2013, n=45 studies; Sipski et al., 2006, n=61).

Men with injuries affecting the lumbar and sacral regions and those with complete LMN dysfunction affecting their sacral segments were less likely to achieve orgasm than were men with any other patterns of SCI (Sipski et al., 2006, n=61). The degree of preservation of combined PP and LT sensation in the T11-L2 dermatomes distinguished those who do and do not have a significant increase in penile circumference with audiovisual stimulation (Alexander and Alexander, 2007, n=61). Lumbar segments of the spinal cord, in particular, appear important in modulating erectile function. Various studies showed that men with SCI lesions above the sacral pathway (complete, partial, and between the 2 pathways) maintained erectile responses to reflexogenic stimulation (defined as reflexogenic erections) and that those with lesions to the conus terminalis and cauda equina maintained erectile responses (defined as psychogenic erections; Courtois et al., 1993, n=71 men with SCI). Moreover, a meta-analysis (Chehensse et al., 2013, n=45 studies) suggested that men with SCI (n=5 studies) were at risk for impairments in ejaculation when the lesions encompassed the T12-L2 segments as opposed to when the injury was above these segments. In particular, ejaculation rate appears to be dependent on the extent and severity of damage within the T12–L2 segments. Ejaculation rates ranged from 86% (n=93, confidence interval [CI] 77.4-91.8) to 4.9% (n=61, CI 1.1-14), depending on the number of completely injured segments between T12 and L2, 0 to 3 ($p<0.0001$) (Chehensse et al., 2013, n=45 studies).

SCI appears to affect fertility in men. Pooled fertility data from a systematic review (13 studies with SCI men from 1993 to 2001) showed a pregnancy rate of 51% and a live birth rate of 40% in partners of SCI men, with the highest success rates among couples who used artificial fertility techniques (DeForge et al., 2005, n=49 studies). A systematic review showed that SCI appears to be associated with abnormal sperm motility and viability in males rather than a lower sperm count, which is comparable to that of the age-matched general population (Patki et al., 2008; number of studies not reported).

Women with SCI

Among women, SCI appears to result in difficulties in physical and psychological arousal (e.g., ejaculation, sensation, and orgasm). Research on women with SCI (Jackson and Wadley, 1999, n=500) showed reduced rates or orgasm, with only 37.3% of participants reporting that they were able to achieve orgasm after injury compared with 79.1% before injury. Additional research found difficulties with both physical and psychological arousal among women with SCI (87.4% of women with SCI reported difficulty becoming physically aroused, and 74.7% reported difficulty becoming psychologically aroused; Anderson et al., 2007, n=87 women with SCI). In contrast, another study showed that 94% of women with SCI had no problems with impaired vaginal lubrication (Biering-Sorenson et al., 2012, n=279).

Predictive studies related to sexual functioning have yielded mixed results, likely due to a lack of large-sample experimental research, along with the complex nature of SCI and sexuality in general. Survey research has identified that the most predominant factors associated with difficulties related to intercourse were injury level (greater difficulties for cervical injuries); having severe spasticity (during typical daily life); having pain, spasticity, or autonomic dysreflexia during any type of sexual activity; and reporting that autonomic dysreflexia interferes with sexual activity (Anderson et al., 2007, n=87 women with SCI). Smaller experimental studies by Sipski et al. (2001, n=89: 68 women with SCI and 21 non-disabled controls) indicated that preservation of sensory function in the T11-L2 dermatomes is associated with psychogenically mediated genital vasocongestion. Less than 50% of women with SCIs in this study were able to achieve orgasm, compared with 100% of non-disabled women ($p<0.001$). Only 17% of women with complete LMN dysfunction affecting the S2-S5 spinal segments were able to achieve orgasm, compared with 59% of women with other levels and degrees of SCIs ($p=0.048$). Time to orgasm was significantly increased in women with SCIs compared with non-disabled controls ($p=0.049$; Sipski et al., 2001, n=89: 68 women with SCI and 21 non-disabled controls).

Women with SCI can become pregnant and carry a pregnancy to term (Biering-Sorenson et al., 2012; Iezzoni et al., 2015; DeForge et al., 2005), despite the common occurrence of amenorrhea after SCI. Although 1 study of 128 women found a 41.4% rate of post-injury amenorrhea, it was most often transient with a mean duration of 7.96 ± 10.9 months. Amenorrhea

did not appear to be related to level of injury, nor did it predict future pregnancy (Bughi et al., 2008, n=128). Pregnancy was associated with being married or living with a significant other, having higher Functional Independence Measure (FIM) motor scores, and having greater values for all Craig Handicap Assessment and Reporting Technique (CHART) subscales and Satisfaction with Life Scores (Iezzoni et al., 2015, n=1,907).

Women with SCI who become pregnant have a higher risk of complications during pregnancy and the postpartum period. In particular, they may be at risk for preterm delivery (Jackson and Wadley 1999, n=472) and for higher rates of labor and delivery complications, including blood pressure instability, premature birth, and low birth weight (<5 lbs 6 oz). Moreover, women with SCI seem to have longer hospitalizations and increased rehospitalizations after giving birth, as well as increased adjusted risks of prenatal UTI or pyelonephritis, venous thromboembolism, preterm rupture of membranes, cesarian delivery, and postpartum depression (Crane et al., 2019). Their infants are more often small for gestational age but have no increased risk of rehospitalization or death. Very low birthweight (<1500 g) is uncommon, but infants of women with SCI, spina bifida, or paralysis have an increased risk for low birthweight (overall relative risk 3.21, 95% CI 1.46-7.05; Crane et al., 2019). Some research suggests that women with SCI appear to be more susceptible to postpartum depression than non-disabled women are (Mitra et al., 2015; Ghidini et al., 2008, n=114) and that women with cervical and upper thoracic SCI may be most at risk (Lee et al., 2019, n=102). Research also suggests that mothers with SCI may have difficulty breastfeeding, in part due to insufficient milk production (Holmgren et al., 2018; Jackson and Wadley, 1999). However, the data are limited.

Recommendations

2.4.1 We recommend that clinicians provide information, resources, and referrals as appropriate to address sexual functioning, socialization, and psychological issues associated with sexual health after SCI (1C).

2.4.2 We suggest that individuals with SCI be provided with resources about sex and sexuality after SCI, including information about where to find accurate publicly accessible information and how to identify it, for themselves and their partners (2C).

2.4.3 We recommend that clinicians provide education and referrals related to reproductive options to achieve or prevent pregnancy as desired by the individual with SCI (1D).

2.4.4 We recommend that women with SCI consult early with an OB/GYN experienced in high-risk pregnancies, as women with SCI who become pregnant are at high risk for complications (1D).

2.4.5 We recommend that women with SCI receive access to occupational therapists, as well as knowledgeable lactation consultants, to optimize parenting outcomes after giving birth (1C).

Rationale

SCI can produce both physical (e.g., decreased, lost, or changed sensation; difficulties in achieving orgasm; bladder or bowel problems; and difficulties moving and positioning oneself) and psychological changes (e.g., feeling unattractive or less attractive, having less self-confidence, and difficulties meeting or finding a partner) that affect sexual activity and functioning (Kreuter et al., 2011, n=532). For both men and women, problems regarding bladder and bowel management, pressure injuries (PIs), spasticity, pain, and autonomic dysreflexia during sexual activity are related to lower satisfaction with sexual life (Biering-Sorenson et al., 2012, n=279; Valtonen et al., 2006, n=190; Jackson and Wadley, 1999, n=472).

Information about sexuality and sexual functioning after SCI, including impairment-specific changes, should be provided to both adults with SCI and their partners in an age- and culturally appropriate manner (Alexander and Alexander, 2007). Moreover, individuals with SCI should be asked about sexuality and sexual functioning throughout their life span in order for the care provider to answer questions and to identify and provide treatment and/or referral for sexual dysfunction (Zizzo et al., 2022; Lombardi et al., 2010).

Many forms of treatment for sexual dysfunction exist and appear to be at least somewhat effective in enhancing sexual function in men with SCI. For men at least 10 years after SCI, 1 study found that, among the 44% of participants who achieved ejaculation, 56% used an ejaculatory aid (Biering-Sorenson et al., 2012, n=279). A systematic review (DeForge et al., 2005, n=66 studies) reported that penile injections resulted in successful erectile function in 90% of men and that sildenafil resulted in a 79% success rate. Another study found that penile vibratory stimulation (PVS) was successful in 86% of patients with a T10 or rostral injury level and that electroejaculation was successful in most cases of failed PVS (91.9% response rate; Bracket et al., n=500). The meta-analysis (Chehensse et al., 2013) also suggested positive results from some erectile treatments, including PVS or angiotensin-converting enzyme inhibitors in patients with both complete SCI and incomplete SCI.

Women with SCI often find it difficult to achieve physical and psychological arousal (Anderson et al., 2007; Jackson and Wadley, 1999). Both women and men with SCI may find value in counseling and in exploring the many sexual aids that have been developed specifically for individuals with disability. Women with SCI benefit from the same family planning education as their nondisabled peers. They should be encouraged to engage with an OB/GYN who understands their special needs in the earliest stages of pregnancy in order to receive appropriate care and avoid risks.

Stakeholders should also refer to the 2010 Consortium for Spinal Cord Medicine's *Sexuality and Reproductive Health in Adults with Spinal Cord Injury* for additional information, recommendations, and rationale.

2.5 Seated Activities (Bed Mobility, Bed and Wheelchair Transfers, and Positioning and Pressure redistribution)

Panel Findings

- Level of injury and severity are associated with seated mobility outcomes.
- Independent tranfers are a functional goal for individuals up to the C7 level of injury, however some may not achieve this goal even when triceps function is preserved.
- Transferring using compensatory strategies and/or devices is a functional goal for individuals up to the C5 level of injury.

Synopsis of Evidence

Higher levels of lesions in individuals with SCI are associated with poorer seated balance (Quel de Oliveira et al., 2019, n=91). Although the literature on seated balance outcomes is limited, stable sitting posture is important for distal mobility. Seated balance is therefore an important prerequisite for transferring, dressing, and other activities of daily living. Lower FIM mobility is associated with higher levels of injury (Middleton et al., 1998). For individuals with injury levels of C5-C6, compensatory strategies may be used to promote independence (Teeter et al., 2012 n=1032). These strategies can include compensation from other muscle groups, such as the pectoralis major, latissimus dorsi, and deltoid muscles (Gagnon et al., 2003, n=11), as well as the use of a transfer board (Hastings and Field-Fote, 2009, table 7-1, p. 137). Reduced elbow extensor, wrist extensor, and finger flexor strength may make it more challenging to stabilize the hand during a transfer (Beninato et al., 2004, n=20). Among individuals without triceps function, those who are younger and who have motor-incomplete injuries have greater independence in transfers (Dengler et al., 2021, n=299). Individuals with an injury level of C7 and below should be able to transfer independently, including from the wheelchair to the floor and from the wheelchair to a vehicle (Hastings and Field-Fote, 2009, table 7-1, p.137). Despite this, only 54%-64% of individuals with C7 or C8 levels of injury are able to transfer independently (Dengler et al., 2021).

Recommendations

2.5.1 We recommend transfer and seated balance training for all individuals with SCI who have weakness in their trunk or upper extremities (1D).

2.5.2 We recommend that seated balance training be task specific, as outcomes may vary for different surfaces (1C).

2.5.3 We recommend that rehabilitation and training focus on optimizing independence and preventing injury, as well as taking into consideration comorbidities and potential for neurorecovery (1D).

Rationale

Transfer training is one of the most common physical therapy activities for individuals with SCI severity classifications AIS A-C (Teeter et al., 2012). Transfer

training has been shown to improve transfer technique for individuals with both acute and chronic SCI (Rigot et al., 2021, n=72; Worobey et al., 2018, n=71; Tsai et al., 2016, n=24). Repeated transfers put the upper extremities at risk for overuse injuries (Boninger et al., 2005), and poor technique has been associated with pathology at the shoulder, elbow, and wrist. Secondary injuries can reduce independence in transfers. Body habitus may be a limiting factor with some aspects of transfer technique, in particular forward lean.

2.6 Wheeled Mobility

Panel Findings

- Level of injury and severity are associated with wheeled mobility outcomes.
- Wheelchair skills training is associated with improved outcomes.

Synopsis of Evidence

Wheelchair use and needs are predicted by lesion level and SCI severity (Table 5). In a large study of approximately 1,300 individuals with SCI who were surveyed about the wheelchairs that were prescribed during inpatient rehabilitation, individuals with tetraplegia were more likely to use a power wheelchair: 79% of those with high tetraplegia (C1-C4 AIS A, B, C) and 60% of those with low tetraplegia (C5-C8 AIS A-C). However, some received a manual wheelchair with or without power options (Taylor et al., 2015).

In a study of 81 individuals at 1 year after SCI, manual wheelchair skills were higher among individuals with paraplegia than among those with tetraplegia (Kilkens et al., 2005). Considerations for type of wheelchair should include not only an individual's ability to propel the wheelchair, but also an individual's ability to navigate the community and the wheelchair skills that may be necessary to do so. For example, individuals with C6 SCI often have limited strength in their pectoralis major, triceps, and wrist or finger flexors, and so may have difficulty propelling a manual wheelchair with enough speed for community ambulation (more so than individuals with C7-C8 SCI or paraplegia; Mulroy et al., 2004, n=69). Upper body impairments may also limit the execution of some skills such as wheelies, ascending a 15-cm curb, or ascending a 10-degree incline (Taylor et al., 2015, n=1,032).

In a large study of over 200 wheelchair users with SCI, compared with those with tetraplegia, more participants with paraplegia could fold and unfold their wheelchair, hold a 30-second wheelie, turn 180 degrees in a wheelie, transfer from the ground to their wheelchair, and descend at least 3 stairs (Hosseini et al., 2012). In this cohort, <50% of individuals with paraplegia could complete a ground-to-wheelchair transfer, ascend or descend a 15-cm curb, or ascend or descend 3 stairs. Of individuals with tetraplegia, <50% could complete the aforementioned skills and were also unable to fold and unfold the wheelchair or perform wheelie skills. A prognostic model for wheelchair usage at discharge in individuals with SCI indicates higher wheelchair skills among those with higher wheelchair skills at baseline, who were male, and who had lower lesion levels (de Groot et al., 2010, n=142). However, most of the variance in the model was due to baseline score, the confidence intervals were wide, and the outcome measure did not include many community-level wheelchair skills such as wheelies and curbs; therefore, caution should be used when interpreting these results.

In a study of over 200 wheelchair users with SCI, greater wheelchair skills were associated with improved community participation, mobility, employment, and physical independence (Hosseini et al., 2012). There is a moderate correlation between higher manual wheelchair skills and fewer participation restrictions, including greater mobility, less confinement, and more social interaction (Kilkens et al., 2005, n=81). A study of approximately 100 individuals showed that at 5 years after discharge, return to work was associated with greater wheelchair skills, as indicated by the ability to complete more skills, to complete skills faster, and to strain less physically while completing skills (van Velzen et al., 2012).

Wheelchair skills training can improve wheelchair skills. A meta-analysis of evidence-based wheelchair skills training demonstrated that for participants with SCI (109 individuals across 3 studies), wheelchair skills training could increase the capacity to complete wheelchair skills by an average of 17.4% relative to a control group (Keeler et al., 2019). Further, a higher dosage of wheelchair training typically results in better functional outcomes. As shown in a large study of over 1,000 individuals, for those with motor-complete low tetraplegia (C5-8), more time spent on manual wheelchair mobility training during inpatient rehabilitation was associated with higher discharge scores on measures of physical functioning (Ozelie et al., 2012). In addition, in a large study of over 1,000 individuals, greater time working on wheelchair skills training was associated with greater independence in transfers, as measured by physical functioning scores for individuals with motor-complete tetraplegia below level C5 (Teeter et al., 2012). Although motor function may limit which skills individuals with tetraplegia can perform, this should not restrict wheelchair skills training. As detailed earlier, wheelchair skills training is effective at improving functional outcomes for all individuals living with SCI. Wheelchair skills training should be pursued in both inpatient and outpatient settings (Taylor et al., 2015).

Recommendations

2.6.1 We recommend that the provision of wheelchair services should include a wheeled mobility evaluation, fitting, configuration, adjustment, programming, and use training in wheelchair maintenance and skills. This process should be facilitated by a physical or occupational therapist experienced with SCI or neurological populations (1B).

2.6.2 We recommend that individuals with SCI be prescribed complex rehabilitation technology that includes individually configured manual and/or power wheelchairs with appropriate seating systems. These specialized devices should be tailored to the user's specific needs to maximize their function, independence, community participation, and mobility while minimizing risks related to skin and joint integrity (1B).

2.6.3 We recommend that manual wheelchair users be prescribed an ultralight weight manual wheelchair that is fully customizable (adjustable and/or configurable) and minimizes overall weight (1B).

2.6.4 We recommend that wheelchairs be equipped with assistive propulsion systems (e.g., power-assist wheels) to reduce the risk of repetitive strain or overuse injuries and improve independence and community participation, in the context of aging or other comorbidities such as obesity (1D).

2.6.5 We recommend that power wheelchair users be prescribed a wheelchair that includes batteries intended to last a full day before charging, has speeds appropriate for community access and navigation, and has electronics that accommodate seating functions (e.g., power tilt, power recline, power elevating legs, and/or power seat elevation) (1B).

2.6.6 We recommend that the seating system (seating cushions, postural supports, and accessories) for both manual and power wheelchairs be customized to the user (1B).

2.6.7 We recommend that consistent wheelchair maintenance is necessary to optimize performance and health outcomes (1C).

2.6.8 We recommend that individuals with SCI receive wheelchair re-evaluation at regular intervals to ensure proper fit, ergonomic set-up, and postural stability over time (1C).

Rationale

In a study of 70 individuals with chronic SCI, the primary reason that individuals cited for limited participation inside the home, outside the home, and during transportation was their wheelchair (Chaves et al., 2004). It is therefore critical that wheelchair service provision include an appropriate assessment and that delivery be paired with proper selection and training in wheelchair skills and maintenance to optimize outcomes (World Health Organization [WHO], 2008; Arledge et al., 2011). The wheelchair assessment should evaluate user posture, comfort, independence for propulsion, activities of daily living, and community access (Taylor et al., 2015; Arledge et al., 2011). A wheelchair assessment is necessary if an individual cannot ambulate functionally or the individual's current wheelchair either does not meet their needs or is beyond repair (Arledge et al., 2011).

For manual wheelchair users, a customizable chair should be considered that minimizes weight and is durable for long-term continuous use (DiGiovine et al., 2012). Optimizing setup may reduce the risk of developing repetitive strain injuries to the upper extremities and secondary consequences. Power options, including both power wheelchair and power assist options for manual wheelchairs, should

be considered for a number of factors, including comorbidities, age, energy conservation, community mobility, and activities of daily living.

For power wheelchair users, the configuration should optimize comfort, function, and safety, including consideration of the mechanical components of the wheelchair (such as the motor or seating functions), electronic components (such as programming to optimize drive), and additional controls for access. Power wheelchair users who are unable to operate their chair through the joystick and/or controller may require augmented controls to turn the wheelchair on and off, operate seating functions, or drive the wheelchair. Seating functions (tilt, recline, and elevating legs) enable the user to change position in a dynamic way in order to realign posture, enhance respiratory and swallow function, redistribute pressure, manage orthostatic hypotension, enhance bladder management via catheterization, manage edema, improve transfer biomechanics, regulate spasticity, accommodate and prevent orthopedic deformities, and improve comfort (Dicianno et al., 2015). Seat elevation allows for changes in the vertical height of the seat, which enables the user to complete activities of daily living with improved biomechanics (such as overhead reaching or transfers) and have improved visual orientation and line of sight (such as for communication, social engagement, and pedestrian safety) (Schiappa et al., 2019).

Maximizing fit and function for individual users includes selecting a wheelchair configuration that accounts for frame design relative to user anatomical dimensions, seating systems that are custom configured for postural stability and pressure reduction or distribution, and accessories that improve ease of propulsion and reduce risk of repetitive stress disorders in the upper extremities (DiGiovine et al., 2012). Use of consistent terminology and measurements related to body segments and postural support surfaces in wheelchairs and wheelchair seating systems is critical to quantify changes that can occur with users over time related to using a wheelchair and to ensure reproducible results in wheelchair prescription (Waugh and Crane, 2013). Wheelchair selection should consider repairability, ease of maintenance, and device reliability (Magasi et al., 2018, n=250).

As described earlier, wheelchair skills training is linked to improved outcomes in mobility, participation, and employment. In a study of nearly 800 wheelchair users with SCI, experiencing a wheelchair breakdown that resulted in adverse consequences was associated with increased pain, decreased self-perceived health status, and increased odds of rehospitalization and PI development (Hogaboom et al., 2018). In a group of nearly 150 individuals, providing training on wheelchair maintenance was shown to increase not only the ability to complete maintenance, but also the frequency at which it was completed among individuals with chronic SCI (Worobey et al., 2022).

2.7 Walking

Panel Findings

- A variety of prognostic indicators related to walking outcomes can inform clinical decision making related to education and plan of care.
- Goals for walking may vary, depending on an individual's goals and prognosis, and may range from the ability to walk for exercise to functional ambulation.
- Primary factors to consider in prediction of outcomes for ambulation include strength motor function, sensation sensory function, age, and AIS Classification
- The definition of what constitutes walking varies in the literature and encompasses a broad range from limited walking ability (primarily for exercise) to safe and functional independent walking in the community. The assessment of walking function also varies and includes self-report or objective measures of level of assistance needed, distance walked, and speed of walking.
- Participating in locomotor training can influence walking outcomes in individuals with AIS C and D SCI.
- Evidence describing locomotor training (with or without neuromodulation) for restoration of walking in individuals with chronic AIS A or B SCI is limited to case reports and does not support it as a viable approach.

Synopsis of the Evidence

Motor function. The influence of lower extremity muscle strength has been extensively examined as a predictor for mobility outcomes following SCI. In a study of nearly 500 individuals, van Middendorp et al. (2011) found that knee extensor and plantar flexor strength were the 2 primary predictors for walking outcomes in combination with other factors (see Combined [Prediction Models] subsection below). Among 90 individuals with motor-incomplete SCI, total LEMS was identified as the variable that best predicts independent ambulation (≥20 on the Walking Index for Spinal Cord Injury, an outcome that assesses the amount of physical assistance and devices needed to ambulate 10 m [32.8ft]) and functional ambulation (>0.6 m/s on the 6-minute walk test, an outcome that assesses how far an individual can walk in 6 minutes; Zorner et al., 2010). Other studies that relate muscle strength to walking outcomes are small (fewer than 25 individuals) and report conflicting findings regarding which muscle groups are associated with faster walking (Kim et al., 2004; Yang et al., 2011; Dipiro et al., 2015).

Sensory Function. Preservation of PP sensation has been studied in relationship to walking outcomes after SCI and is a factor to consider when determining prognosis for ambulation. The presence of sacral PP sensation at 1 month after injury is predictive of ability to walk 25 feet with or without assistance at 1 year after injury. Conversely, sacral PP sensation at 72 hours after injury is not predictive. Preservation of PP sensation in at least 50% of lower extremity dermatomes is associated with a higher likelihood of being able to ambulate at 6 months and 1 year after injury (Oleson et al., 2005, n=131). Preservation of lower extremity PP sensation as a prognostic indicator for ambulation is further supported in another study of 249 individuals with AIS B for walking household distances at 1 year after injury. Preservation of lower extremity PP sensation at baseline 2-4 weeks after injury in at least 50% of the lower extremity dermatomes is related to increased likelihood of ambulation in individuals younger than 50 years old; the relationship could not be tested in this study for those ≥ 50 years due to the small number of individuals who became ambulatory in that group (Oleson et al., 2016).

Age. Age is a factor that contributes to determining prognosis for ambulation after SCI. The van Middendorp clinical prediction rule (see Combined [Prediction Models] section below) assigns the greatest weight in the prediction model to age, with ≥ 65 years resulting in the deduction of the greatest number of points (10) in the model (van Middendorp et al., 2011). Age was a significant factor considered with the same cutoff (≥65 years) when Hicks et al. (2017) generated a simplified version when revalidating the van Middendorp model. in their study, Engel-Haber et al. (2020) included over 600 individuals to evaluate both the van Middendorp and Hicks models, concluding that using 50 years as a cutoff leads to greater accuracy of prediction of ambulation (Engel-Haber et al., 2020). Burns et al. (1997), in a sample of over 1,000 individuals with SCI, concluded that those < 50 years of age are more likely to be able to walk 50 feet without assistance by discharge from inpatient rehabilitation; this difference holds true for individuals with AIS C SCI, but is not significant for those with AIS D SCI. In contrast, in another sample of over 300 individuals, those who were < 50 years had a greater likelihood of walking at discharge from inpatient rehabilitation with moderate assistance or less; however, this relationship is only significant for those with AIS D, not AIS C (Kay et al., 2007).

AIS Classification. AIS classification is a key predictor of locomotor recovery following SCI. Kay et al. (2007) investigated AIS classification in a sample of over 300 individuals within 72 hours of admission to inpatient rehabilitation and the associated likelihood of walking with moderate assistance or less at discharge from inpatient rehabilitation. For individuals with AIS D SCI, 67.2% achieved this level at discharge compared with 28.3% of those with AIS C and 0.9% of those classified with AIS A or B. For individuals with AIS C and D, injury level was not associated with walking at discharge even when age and time since injury were accounted for (Kay et al., 2007). These results differ from historical data from a sample of over 1,000 individuals in which 100% of those with AIS D and 67% of those with AIS C walked 50 feet without assistance from another person by the time of discharge (Burns et al., 1997). These differences may be explained by longer lengths of stay that were more common during the period of the earlier study, or the differences in how ambulation was defined (Wilson et al., 2012b). Using AIS grade as a predictor of 1-year walking outcomes, van Middendorp et al. (2011; n = 492) reported that the percentage of individuals able to walk independently at least 10 meters indoors one year after injury was 8.3% for AIS A, 39.4% for AIS B, 61.8% for AIS C, and 97.3% for AIS D, based on AIS classification obtained within the first 15 days post-injury.

Combined (Prediction Models). A number of clinical prediction rules, tools that use demographic characteristics and clinical measures to determine the probability of an outcome, exist for assessing the likelihood of walking following SCI. The most-cited clinical prediction rule is that by van Middendorp et al. (2011), which is based on measures obtained during the first 15 days following injury. This prediction rule indicates that walking 10 m independently indoors at 1 year after injury is more likely among those who are younger (<65 years vs. ≥65 years) and who have greater strength and sensation at L3 (quadriceps and front of thigh) and S1 (plantar flexors and posterior leg). These findings were based on a European cohort of nearly 500 individuals and have since been validated with cohorts from Canada (n=278) and the United States (n=184) (Hicks et al., 2017; van Silfhout et al., 2016). This clinical prediction rule has also been applied to a smaller cohort of 50 individuals with nontraumatic SCI in which it well predicted those who would not walk, but was less accurate in predicting walking, in particular among those with incomplete injury (Sturt et al., 2020). A simplified version of this model has also been evaluated, which shows similar results based only on the factors of age, strength at L3, and sensation at S1 (Hicks et al., 2017).

In a study of over 3,000 individuals, self-reported ability to walk ("yes" or "no") household distances, a street block, and a flight of stairs at 1 year after injury is predicted based on age (<65 years vs. ≥65 years) and strength in L2 (hip flexion), L3, and S1 (Belliveau et al., 2016). Additional clinical prediction rules have been developed that identify more favorable outcomes among those with greater lower extremity strength (Wilson et al., 2012b; Hicks et al., 2017), who are younger (Wilson et al., 2012b; Oleson et al., 2016; Hicks et al., 2017; van Middendorp et al., 2011; Zorner et al., 2010; Kay et al., 2007; Engel-Haber et al., 2020), and who have incomplete injury (Zorner et al., 2010), as well as with the presence of PP sensation (Zorner et al., 2010) and tibial somatosensory evoked potentials (Zorner et al., 2010). Cutoff values for age used in prediction models vary and include 50, 60, and 65 years (Engel-Haber et al., 2020; Kay et al., 2007; Zorner et al., 2010; van Middendorp et al., 2011; Hicks et al., 2017).

A limitation of some of the CPRs (i.e., those based on van Middendorp et al , 2011) is that they define "walking" very broadly. The operational definition of walking encompassed a broad spectrum of functional abilities, ranging from ambulation restricted to short indoor distances (e.g., 10 meters) to full community ambulation. In contrast, three recent CPRs specifically target prediction of those who will achieve at least 100 meters of outdoor, community-relevant walking. Jean et al. (2021, n=159) identified L3 and L5 motor strength and S1 light-touch sensation as the strongest acute predictors and produced an easy-to-use CPR with roughly 85% accuracy. Draganich et al. (2023, n=3721) externally validated the 3-variable CPR of Jean et al. (2021) in a large multisite U.S. cohort, confirming high predictive performance (AUC = 0.90) for outdoor walking at 1 year. Seeking an even simpler clinical tool, Smith et al. (2024) showed that a single S1 pinprick sensory test—normal, impaired, or absent—predicts future independent indoor and outdoor walking with approximately 64–85% accuracy.

Although the comprehensive approach of clinical prediction rules is preferred to the use of single predictors, limitations associated with these studies should still be considered. In several studies, there is a smaller representation of those with AIS B and C for whom outcomes can be more challenging to predict; this can bias the sample and overestimate predictive accuracy (Phan et al., 2019; Nater and Fehlings, 2017). The definitions of "walking" encompass forms of ambulation that differ substantially from how the individual walked prior to injury (i.e., slower speeds, use of assistive devices and/or orthotics). In addition, different metrics of ambulation are used across studies (e.g., self-report, ability to walk a short distance, and the need for assistance), which may not represent actual daily mobility.

Locomotor Training. Locomotor training is defined as the repetitive and intensive practice of walking tasks with the goal of recovery of ambulatory function (Mehrholz et al., 2017). The term "locomotor training" is often used interchangeably with "gait training"; however, in the latter case, the focus is on learning to produce a more typical or efficient gait (i.e., biomechanics of walking). This may mean cuing for step biomechanics (lift knees higher, take longer steps, etc.) or using assistive devices with a safer or more efficient pattern rather than providing intensive task-specific practice (Field-Fote, 2020). A variety of strategies can be used to implement locomotor training, including overground, use of a treadmill, use of robotic devices, and use of body weight support.

All forms of locomotor training are effective in improving walking outcomes in individuals with incomplete SCI, as demonstrated in a variety of studies with a number of participating individuals as follows: 88 individuals (Esclarin Ruiz et al., 2014), 146 individuals (Dobkin et al., 2006), 13 studies that examined 586 individuals (Mehrholz et al., 2017), and 15 studies that examined 102 individuals (Louie et al., 2015). Studies with sample sizes of between 100 and 150 individuals support the evidence that those who begin rehabilitation early after SCI have improved walking outcomes (Dobkin et al., 2006, 2007).

In an RCT, 146 individuals with subacute AIS B (within 8 weeks of injury) were randomized to 12 weeks of treadmill-based training vs. standard physical therapy that included overground locomotor training. Improvements of 1 or more AIS grades were observed in 80% of individuals, with no differences in outcomes identified between interventions (Dobkin et al., 2006). In a report of 225 individuals with chronic motor-incomplete SCI, they engaged in extended locomotor training (average of 60 training sessions), with AIS classification available for 144 participants. Of the 32 individuals with baseline AIS C severity, 9 improved to AIS D. Significant improvements in walking speed, distance, and balance were also observed regardless of initial classification of AIS C or D (Buehner et al., 2012). Locomotor training continues to be beneficial in the chronic motor-incomplete SCI population (>6 months) for improving walking speed and distance, as described in a 2020 CPG (Hornby et al., 2020).

Although a few case reports describe improvements in overground walking in individuals with chronic AIS A or B SCI (Manella et al., 2010; Spiess et al., 2012; Murillo et al., 2012), these improvements likely reflect a ZPP extending to the hip flexors. Further, in all cases, the individuals were reported to have lower extremity spasticity that likely contributed to weight support during walking. A case series of 4 individuals with motor-complete SCI showed outcomes from an intervention of epidural stimulation combined with extended locomotor and standing training. Two individuals (who received 81 or 278 training sessions) were able to achieve some level of overground walking ability, with 1 individual experiencing a hip fracture during training. For 1 of the individuals who achieved overground walking, speed was reported as 0.19m/s (0.43 miles/hour) and fatigue was a key limitation. Walking metrics for the second individual were not reported (Angeli et al., 2018).

Recommendations

2.7.1 We recommend regular evaluations of sensory and motor function to monitor change in neurological status that may be the basis for modifying the plan of care. This may include a complete ISNCSCI or portions of the examination to help in the clinical reasoning related to determining a prognosis for ambulation (1D).

2.7.2 We recommend balancing potential neurorecovery with optimizing independence in mobility in the context of a limited amount of time in rehabilitation, considering the mode of mobility at discharge and at 1 year (whether walking, wheelchair, or a combination of these) (1D).

2.7.3 We recommend, when the plan of care includes ambulation training, that interventions be initiated early and include principles to maximize neuroplasticity such as intensity, repetition, and task specificity (1B).

2.7.4 We recommend the use of comprehensive clinical prediction rules that consider multiple clinical and personal factors and body functions (1B).

Rationale

Studies in the literature define ambulation differently, ranging from moderate assistance to no assistance, and walking 10 m indoors to community ambulation. These factors should be considered when interpreting the literature and applied to the clinical decision making with respect to goal setting and plan of care. There are also differences in the predicted end point (discharge vs. 1 year after injury) and variations in length of stay and standard of care based on geography and how long ago the study was conducted (Burns et al., 1997; Kay et al., 2007; van Middendorp et al., 2011; Wilson et al., 2012b).

Sensory and motor function, AIS classification, and age are key predictors related to walking outcomes. In general, prediction rules for ambulation outcomes

are based on measures obtained immediately after or within the first month following injury. Although there is no uniformly accepted definition for functional ambulation, community participation is widely accepted as a critical outcome of rehabilitation for individuals with SCI. Accordingly, those who cannot ambulate community distances will likely require wheelchair skills training to fully participate in their community. In a study of over 500 individuals who used a wheelchair at discharge from inpatient rehabilitation, those who received locomotor training or gait training (approximately 50%) spent less time receiving training in transfers and wheeled mobility (Rigot et al., 2018). Individuals in this group had lower physical independence, were less likely to move about effectively in their surroundings, and were less likely to occupy time in a manner customary to others of similar sex, age, and culture at 1 year after injury compared with those who did not receive gait training (Rigot et al., 2018).

A large RCT with 146 individuals with subacute SCI compared overground walking training to treadmill training, with a primary outcome of walking speed, with no differences between groups identified in walking-related outcomes (Dobkin et al., 2006). It was argued that the reason no differences were identified was that the amount and intensity of locomotor training provided to those in the overground group was greater than in earlier studies and that this was key to individuals achieving these outcomes. A systematic review of randomized controlled trials of interventions to improve walking in persons with chronic SCI identified 13 studies with data from 586 participants. Of the 9 trials with usable data comparing body weight supported treadmill training versus overground training, outcomes favored overground training. Of the 3 trials providing usable data comparing robotic-assisted training to overground training, outcomes favored overground training (Mehrholz et al., 2017).

A CPG on recommendations related to improving walking speed and distance in individuals with stroke, traumatic brain injury (TBI), and SCI (Hornby et al., 2020) recommends high-intensity locomotor training for individuals with chronic (>6 months) motor-incomplete SCI. These recommendations are primarily generalized from studies of individuals with stroke, as there are limited data examining training intensity among individuals with SCI (Leech et al., 2016; Brazg et al., 2017).

Clinical prediction rules consider multiple factors and combine them to make predictions related to recovery of walking. These studies have large sample sizes and some have been revalidated in other populations (van Middendorp et al., 2011; Hicks et al., 2017; van Silfhout et al., 2016; Engel-Haber et al.; 2020; Zorner et al., 2010; Belliveau et al., 2016; Kay et al., 2007). These factors allow for more robust predictions than do single predictors alone.

It is important to be mindful that mobility is a multi-faceted concept defined by an individual's capacity to effectively navigate and interact with their environment. While walking is a frequent focus, it may not be the most relevant outcome for every individual, and alternative functional goals may offer a more direct path to independence and quality of life (Rigot et al., 2018; Clifton and Bourke, 2025).

2.8 Arm and Hand Function (Eating, Grooming, Dressing, and Bathing)

Panel Findings

- ISNCSCI examinations completed 72 hours to 1 week and 1 month after injury are highly predictive of upper extremity-related neurological outcomes at 6 months and 1 year. A greater likelihood of upper limb recovery is predicted by spinal surgery within 24 hours, a higher degree of motor function at baseline, conversion from AIS A to AIS C within 3 months, and having a ZPP of ≥ 3 sensory levels or ≥ 2 motor segmental levels.
- Individuals with an injury classification of AIS C have the greatest change in neurological status, followed by those with AIS B, AIS D, and then AIS A for both upper and lower extremities.
- Greater upper limb recovery is predicted by conversion from AIS A to AIS B within 12 months, having lower cervical injuries (C5-C7), and being younger at the time of injury. However, evidence related to the influence of age is mixed.
- Pain limits independence in activities, including transfers.
- Individualized, progressive resistance exercise training is important in building and maintaining upper extremity strength. Glenohumeral joint motion and pectoral muscle mobility are important in achieving and maintaining shoulder flexibility.
- The use of functional electrical stimulation (FES) can improve upper extremity independence scores in the short term, but its long-term impact and success in individuals with chronic SCI are not known.
- Activity-based interventions such as task-specific training, weight-bearing, and whole-body muscle strengthening can have positive effects on motor FIM scores and self-care scores in the first 3-12 months after SCI. Small to moderate improvements may continue after 12 months with some individuals.

Synopsis of Evidence

Motor recovery is largely determined by initial AIS classification. The use of the AIS and ISNCSCI examinations after SCI performed at 1 month after injury have generally not been found to predict recovery. Kirshblum et al. (2021, n=187) suggest that examinations within 24 hours to 1 week after injury are similarly reliable to predicting neurological outcomes at 6 months and later. Typically, recovery follows a pattern wherein individuals with injury severity classified as AIS C experience the greatest recovery, followed by those with AIS B, D, and then A. In individuals with motor-complete cervical SCI (C4-C7), most upper extremity motor recovery will be in the first 6-12 months. This study also found that approximately 30% of individuals with initial severity classification of AIS A converted to incomplete status (roughly one-half of these improving to AIS B and one-half improving to AIS C and D), and 50% of initial AIS B converted to motor-incomplete status, with statistically significant improvements in upper motor function.

A retrospective study by Blessing et al. (2021, n=655) investigated characteristics that predicted recovery trajectories for individuals with traumatic cervical SCI. Their recovery trajectories were classified as marginal recovery, moderate recovery, and good recovery. Those with marginal recovery had minimal or no improvement in motor strength and no change in AIS classification after 12 months; ≥ 31% had improvement in UEMS. Those with moderate recovery experienced a 1-point improvement in AIS classification (i.e., AIS A > B) within 12 months, and increased by an average of 13 motor points in the 12-month follow-up period. Those with good recovery improved an average of 2 AIS classification categories (i.e., AIS A > C) within 3 months, and UEMS improved from 36 out of 50 at baseline to 48 out of 50 at 12-month follow-up. This study also found that recovery trajectories of moderate or good were more likely to be observed in individuals who were younger, had lower cervical injuries of C5-7, and had a higher degree of preserved motor and sensory function at baseline. They also had surgery within 24 hours of injury and had a ZPP of ≥ 3 sensory levels or ≥ 2 motor levels (Blessing et al., 2021).

Another retrospective study by Steeves et al. (2011, n= 426) found that the initial cervical motor level was not a significant factor in UEMS recovery after traumatic cervical SCI. Rather, at 1 year, 70% of participants in the study spontaneously recovered a motor level. This conflicts with newer research as described earlier that the AIS score is predictive, but also predicts improvement in motor scores within 1 year.

A large retrospective analysis assessed how changes in arm and hand function relate to ability to independently perform clean intermittent catheterization (Elliott et al., 2019a, n=1,428). Initial AIS classification and improvement in AIS classification over the first year after injury were significantly associated with the ability to perform clean intermittent catheterization. In a smaller study, active elbow extension at 3 days after injury predicted the ability to use a spoon 6 months later (Hayashi et al., 2013, n=60). In the same study, UEMS and LEMS were correlated with greater independence in eating a meal. Findings related to the impact of age on arm and hand function are mixed.

A weak correlation between younger age and better recovery of finger movement is reported by some investigators (Hayashi et al., 2013, n=60). However, Wirz et al. (2015, n= 413) found similar baseline UEMS scores for older and younger participants with incomplete and complete SCI, as well as no significant changes in UEMS scores between the 2 groups at 5 months after injury. However, at 5 months, changes in Spinal Cord Independence Measure scores were significantly greater in the younger group. In the SCIRehab study (Whiteneck et al., 2012; Teeter et al., 2012; Ozelie et al., 2012; Cahow et al., 2013, n=1,376

total participants), older age was associated with lower discharge scores on measures of function. This should be interpreted cautiously, as the measure used (FIM) has low sensitivity to changes in upper extremity function.

Pain has a negative impact on ability to perform functional activities. In a survey by Dalyan et al. (1999, n=130), 65% of participants who were able to independently transfer or transfer with minimal help reported that upper extremity pain interfered with transfers. Twenty-six percent reported that they needed assistance for functional activities due to upper extremity pain, which is further supported by 28% reporting limitations in independence because of upper extremity pain.

The Consortium for Spinal Cord Medicine CPG, *Preservation of Upper Limb Function Following Spinal Cord Injury* (Boninger et al., 2005), recommends individualized and progressive resistance training to exercise all major muscle groups to the point of pain-free fatigue. It also recommends flexibility exercises to maintain glenohumeral motion and pectoral muscle mobility. A systematic review by Kloosterman et al. (2009, n=185) demonstrates significant improvements in upper extremity motor control or functional ability following exercise therapy or exercise therapy combined with either electrical stimulation or biofeedback at short-term follow-up in 6 of 8 studies. However, small sample sizes make it difficult to generalize to all individuals after SCI.

A meta-analysis was performed on 31 studies of various rehabilitation training interventions (Duan et al., 2021, n=1,040), including transcranial magnetic stimulation, FES, activity-based therapy, and robotic-assisted locomotor training. This study noted no significant increases in upper extremity function in 6 of 6 studies that used FES, but the studies involved combinations of individuals with subacute SCI of < 6 months from date of onset and chronic SCI. In a systematic review and meta-analysis on activity-based therapy interventions, Quel de Oliveira et al. (2017, n=639) found a small to moderate effect on improving upper extremity independence and mobility. The use of electrical stimulation or robotic devices was excluded from these studies, which focused on facilitation, weight-bearing, and massed practice of muscles below the level of the lesion. However, small sample sizes make it difficult to generalize to all individuals after SCI.

Recommendations

2.8.1 We recommend assessing for neuropathic or musculoskeletal pain that can limit upper extremity function and providing education about upper extremity preservation techniques to prevent functionally incapacitating pain (1B).

2.8.2 We recommend interventions to increase flexibility, strength, and endurance for the upper extremities for all individuals after SCI, during initial rehabilitation, and during the life span (1C).

2.8.3 We recommend combining task-specific training, weight-bearing, and whole-body strengthening, augmented by electrical stimulation where appropriate, to increase potential for improvement in upper extremity outcomes after acute and chronic SCI (1D).

Rationale

Repeat AIS or ISNCSCI examinations in rehabilitation settings can help document changes in scores and classifications from complete to incomplete injuries (Kirshblum et al., 2022). Classification can help predict recovery in upper extremity motor function, but is only part of the equation of age, baseline health, and comorbid conditions weighing in on functional outcomes. Greater neurological sparing and improvement in AIS classification in the first year after injury are strong predictors of upper extremity function (Elliott et al., 2019b; Hayashi et al., 2013); therefore, interventions focusing on motor strengthening and recovery should be targeted.

Multiple studies have investigated the effects of activity-based therapy or interventions on upper extremity independence and function (Boninger et al., 2005; Kloosterman et al., 2009; Quel de Oliveira et al., 2017, 2019; Duan et al., 2021). Small sample sizes and multiple interventions that fall into activity-based therapy make it difficult to identify specific interventions, intensity levels, and long-term effects that can be generalized to individuals with SCI by level of injury, chronicity, or potential for improvement. Pain has a negative impact on upper extremity functional activities, including transfers (Dalyan et al., 1999). Therefore, individuals with SCI should be assessed for neuropathic or musculoskeletal pain that can reduce upper extremity functional performance. Individuals with SCI should be educated in upper extremity preservation techniques.

2.9 Transportation and Driving

Panel Findings

- Accessible transportation is among the most common environmental barriers cited by individuals with SCI.
- Independent driving ability and access to a private vehicle have been associated with increased rates of community reintegration and employment. Ability and access to driving an adapted vehicle has a meaningful impact on health and QOL.
- Almost two-thirds of those who lack access to long-distance transportation report having unmet health care needs.

Synopsis of Evidence

Environmental barriers affect more than convenience: they can have serious consequences for the well-being of individuals with SCI. Lack of ability or access to driving or accessible transportation is among the most common environmental barriers cited by study participants with SCI (Whiteneck et al., 2004). The risk of experiencing unmet SCI-related health care needs is almost 3 times higher for those with problems accessing long distance transportation than for those without these difficulties (Ronca et al., 2020). Not surprisingly, satisfaction with transportation is highest among those who are able to drive their own vehicle (Carpenter et al., 2007).

Individuals with SCI who drive after SCI have significantly better community reintegration and health-related QOL than do those who do not drive. Slightly over one-third of study participants with SCI report driving an adapted vehicle. The likelihood of driving is related to motor function, with each additional point on the motor scores in measures of physical functioning increasing the likelihood of driving by 2% (Norweg et al., 2011, n=3,276). Conversely, use of a power wheelchair is associated with a lower likelihood of driving (Tsai et al., 2014a, n=2,986). Factors associated with adapted driving included younger age at time of injury, longer time after injury, education beyond high school, being White, being male, and having paraplegia (Norweg et al., 2011; Francheschini et al., 2003).

Driving is significantly related to health-related QOL variables, including depression, life satisfaction, general health, and pain interference (Norweg et al., 2011) and is also significantly related to autonomy and QOL (Francheschini et al., 2003). Individuals with SCI who drive spend more days per week out of their home and have more friends and business associates to contact (Tsai et al., 2014a). Driving a car was positively related to scores of mobility, physical independence, occupation, and social integration (Tsai et al., 2014a). Driving increased the odds of being employed by almost 2 times compared with not driving after injury (Norweg et al., 2011).

Recommendations

2.9.1 We recommend that individuals with SCI have access to information and training in the use of accessible transportation options early in their rehabilitation (1C).

2.9.2 We suggest that opportunities be provided for participation in an adapted driver education program as a way of increasing confidence in ability to drive for individuals with SCI who have the physical and cognitive capacity for driving (2C).

Rationale

Among those who did not drive, factors that would improve satisfaction included increased availability of shared transit services for individuals with disability and more convenient bus routes and stops (Carpenter et al., 2007, n=357). Individuals with SCI experience restrictions in their access to driving, as shown in a study of almost 4,000 individuals by Tsai et al. (2014a), in which they found that over 40% of those surveyed reported lack of access to an adapted vehicle.

The most common barriers to driving cited are fear and lack of confidence, medical reasons, and inability to afford vehicle modifications (Lee et al., 2018). The barrier of fear and lack of confidence may reflect limitations in access to appropriate disabled driving instruction. Vehicle adaptations can make driving possible for many individuals with SCI, with required adaptations depending on upper extremity function,

such as ability to load the wheelchair into a car, ability to transfer into and out of the car, and whether limited hand function necessitates hand controls (DiStefano and MacDonald, 2009; Flint Rehab, 2021; Model Systems Knowledge Translation Center, 2015).

Car adaptations that may make driving possible for individuals with SCI may include hand controls (for steering, braking, and acceleration), all-direction seat adjusters, and reduced effort or specialized steering (e.g., joysticks or levers). For adapted vans, additional modifications may include automatic doors, wheelchair lifts or ramps, and wheelchair locking systems (for those who drive while seated in the wheelchair). However, even those who own vehicles may encounter barriers to driving; satisfaction with driving would be improved by monitoring disabled parking places, greater availability of full-service gas stations, and more convenient disabled parking (Carpenter et al., 2007).

2.10 Skin Care Behaviors (e.g., Pressure Redistribution, Skin Checks, Proper Positioning, Limiting Sitting Time)

Panel Findings

- Pressure injury (PI) prevalence after SCI is approximately 32% worldwide.
- PIs can occur during the hospital stay and at any time after discharge.
- Multiple risk factors are associated with skin health issues after SCI—older age at time of injury, longer time since injury, multiple medical comorbidities, lack of a social network, being male, and having a complete injury being among the strongest risk factors.
- PIs can take several months to heal, and some never do, negatively affecting health outcomes (hospitalization and comorbid health conditions) and community participation and QOL.

Synopsis of Evidence

In a systematic review and meta-analysis of 24 studies that included over 600,000 participants, Shiferaw et al. (2020) reported that the global prevalence of PIs in individuals with SCI is 32.36%, with the highest magnitude observed in Africa at 41%. In another study, Le Fort et al. (2017) reported that 73.4% of individuals with SCIs presented with at least 1 PI within the 10-year study duration.

A large cohort study by Scovil et al. (2019, n=2,391) indicates that PIs can be acquired during the inpatient rehabilitation stay, with up to 14% of individuals presenting with at least 1 PI. Development or worsening of PIs can start as early as 1-3 months after discharge from inpatient rehabilitation, with 1 study reporting their occurrence in 51.7% of individuals (Guihan et al., 2014, n=143). Other studies indicate that the development of PIs can increase length of stay in a care facility by up to 15 days (Lessing et al., 2020). Based on data from the National Spinal Cord Injury Statistical Center, the overall prevalence of PI among persons with SCI is approximately 30%. The highest levels of PI were seen in individuals with more severe injury and those with injury chronicity of 20 years or more (Chen et al., 2022). In a cohort of veterans with SCI, 33% had PIs in the prior year (Smith et al., 2008). Furthermore, PIs are among the leading causes of mortality in individuals with SCI (Cao et al., 2019, n=2,979; Krause et al., 2008, n=1,389; Krause and Saunders, 2011, n=1,361).

Multiple risk factors are associated with PI, including sociodemographic, neurological, medical or biological, impairment, and disability. A systematic review by Gelis et al. (2009), identified the following 2 strong factors that contribute to chronic PIs: men are more likely to develop PIs than women, and cervical-level injuries are most at risk. Of medical risk factors, the strongest correlation is with deep venous thrombosis and infectious pneumopathy. A strong situational risk factor is the lack of a social support network. PI risk is also related to sensory and motor function, as individuals with AIS A SCI have 4.5 times greater risk than those with injury classified as AIS B, and 4.6 times more risk than those with AIS C (Brienza et al., 2018, n=104). In a large study by Miller and Anderson (2019, n=1,753), PIs occurred in 12% of study participants who were ambulatory, as opposed to 35% in those who were nonambulatory. Those who were nonambulatory also had more severe PIs and worse outcomes (Li et al., 2017, n=350).

Moderate risk factors for PI have been identified in 2 cross-sectional studies. In their systematic review, Gelis et al. (2009) identified factors that influence risk for developing PIs, including marital status, level of education, unemployment, age at time of injury, traumatic vs. nontraumatic etiology, lower limb fractures, autonomic dysreflexia, metabolic syndrome, PI history, mobility level, bowel or bladder incontinence, and hospitalizations related to PIs. In a large study, Li et al. (2017, n=350) found that African Americans are more likely to have poorer PI outcomes, especially with higher injury levels and longer times after injury. This higher risk is likely due to challenges in identifying skin changes in individuals with darker skin tones (Guihan et al., 2008, n=64). Guihan et al. (2016, n=206) found that 40% of individuals in their study needed to be hospitalized for PIs. In a retrospective study, Gould et al. (2014, n=119) suggested that 26% of PIs may heal within a 3-month time frame, but that 10% never successfully heal. Hospitalizations and living with chronic PIs can have a negative impact on health and QOL.

Saladin and Krause (2009, n=475) showed that the lowest prevalence rates for PIs were reported by Hispanic followed by White individuals, with racial-ethnic differences in the odds of developing a PI within the past 12 months. Three barriers were identified with racial-ethnic differences that prevented individuals from being compliant with bed rest to heal a PI: (1) needing someone to stay with them, (2) not having enough money to pay an assistant for the help that is needed, and (3) boredom. Caucasians reported the highest rates for all 3 barriers compared with Hispanic individuals, who reported the lowest rates for all 3 barriers. Notable racial-ethnic differences were identified for barriers that prevented an individual from seeking medical attention for treatment of a PI: (1) lack of insurance and (2) lack of transportation. African Americans and American Indians reported the highest rates for these 2 barriers compared with Caucasians and Hispanics, who had less concerns about these issues. Increased risk of PI was also associated with social support and SCI severity.

Scovil et al. (2019, n=2,391) examined implementation of 2 best practices for PIs in 6 Canadian SCI rehabilitation centers using the Active Implementation Framework. The framework included comprehensive risk assessment with individualized prevention planning and structured patient education. After implementation, risk assessment completion rates improved from 46% to 94%, and patient knowledge of prevention strategies improved. While the framework successfully improved adoption of PI prevention best practices, PI incidence did not change, indicating additional measures are needed.

The Consortium for Spinal Cord Medicine's CPG *Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury* (2014) offers a comprehensive review of PI after SCI. It summarizes the extensive literature on outcomes of direct nonsurgical and surgical management of PIs, as well as on treatment of osteomyelitis in stage 4 PIs. Direct nonsurgical or surgical management of PIs is highly individualized and variable, making it challenging to conduct high-quality research. Moreover, individuals with SCI are a heterogenous population, and risk factors, presentation, and characteristics of wounds are highly diverse, adding difficulty to scientific investigation. Consequently, there is a paucity of studies and lack of evidence for outcomes related to use of specific wound dressings and agents, methods, and surgeries. This remains true for outcomes related to treatment of osteomyelitis in stage 4 PIs as well.

Recommendations

2.10.1 We recommend that prevention of pressure injuries (PIs) be prioritized and that the health care team address underlying risk factors, including decreased mobility, loss of sensation, neurogenic bladder and bowel, spasticity, susceptibility to infections and hospital admissions, smoking, diabetes, obesity, malnutrition, and polypharmacy (1C).

2.10.2 We recommend that education be provided to individuals with SCI and their caregivers about skin health, the need for daily skin monitoring and reporting of skin changes, and prevention of PIs throughout their lifetime (1D).

2.10.3 We recommend early evaluation and management of PIs, correction of underlying risk factors, provision of appropriate equipment, and identification of cellulitis or osteomyelitis to prevent progression and promote wound healing (1D).

2.10.4 We recommend that clinicians identify all relevant person-specific risk factors for PI development when developing a plan of care for individuals after SCI in hospital and community practices. This includes differences in ability to recognize skin changes in individuals with darker skin tones (1D).

2.10.5 We recommend the use of telehealth to evaluate skin breakdown. A clinic visit can be scheduled subsequently if necessary (1D).

2.10.6 We recommend that appropriate equipment (e.g., wheelchairs, seating systems, hospital beds and support surfaces, bathing and toileting equipment) be procured by qualified professionals at the time of acute or rehabilitation hospital discharge (1D).

2.10.7 We recommend that changes in posture, body conformation and weight, friction and shear forces, and skeletal deformities be addressed relative to positioning in a wheelchair, bed, and other sitting surfaces such as a commode or shower chair (1D).

2.10.8 We recommend that alternating pressure air surfaces and reactive gel surfaces for bed mattresses be provided to prevent and reduce the risk of PIs and to facilitate healing (1D).

2.10.9 We recommend that wheelchair pressure redistribution maneuvers be completed as often as possible, at least every 30 minutes during sitting. For power wheelchair users, this includes use of power tilt and power recline, or power standing, and for manual wheelchair users or those without power seating functions, this includes forward and lateral weight shifts (1A).

Rationale

There is evidence that skin care education and telehealth interventions have value for reducing the risk for PI. Guihan et al. (2016, n=206) found that skin health elements that focused on prevention of PIs (medical and physical history; psychological, social, and vocational assessments; smoking cessation; skin assessment; seating evaluation; wheelchair, activities of daily living, and functional assessment; dietary and nutritional assessment; prosthetic equipment and safety; review of medication and supplies) were documented more for hospitalized veterans (80.3%) than for those living in the community who were receiving annual evaluations (64.3%), noting more emphasis on prevention during the hospital stay than when receiving outpatient follow-up care. A retrospective study by Evardone et al. (2018, n=106) found that veterans who attended at least 1 skincare education course while in acute rehabilitation had fewer PIs at 90 days after discharge than did veterans who did not participate, although findings were not significant. Hug et al. (2018, n=456) studied self-efficacy related to PI prevention. They reported some associations between general self-efficacy and the performance of PI prevention at night, completing daily skin checks, and maintenance of anti-pressure injury devices, indicating that greater self-efficacy was supportive of regular PI prevention. Studies have examined the value of telehealth interventions for reducing PIs and depression and enhancing the use of appropriate health care. Houlihan et al. (2013, n=142) indicated a reduction in PIs in 6 months in women, but no difference in men. Mercier et al. (2015, n=106) found no treatment effect with telehealth interventions, but noted that 46% of participants did not know whether they even had a PI at the time of the study.

As part of education, an understanding of pressure redistribution techniques is essential. Multiple studies (n= 102) have shown that the use of a forward, elbows-to-knees or lateral trunk of 15 degrees to complete pressure redistribution maneuvers by manual wheelchair users is effective, assuming they have sufficient trunk or arm control to return to the original upright and midline position (Makhsous et al., 2007; Sonenblum et al., 2014; Wu and Bogie, et al., 2014; Smit et al., 2013). Duration of holds for the pressure redistribution maneuvers in these studies varied from 1-3 minutes. Often individuals with SCI are not able to hold a push-up or vertical lift for a duration of 1-2 minutes, and this maneuver may also decrease the subacromial space, putting the shoulder joint at risk for repetitive use injury (Consortium for Spinal Cord Medicine, 2014). Using power tilt and recline can be more effective for pressure redistribution than either tilt or recline alone (Titus et al., 2019).

Prevention of PIs is essential in maintaining the health and well-being of individuals with SCI due to the high incidence and prevalence of PIs leading to significant morbidity and mortality. It is critical to educate individuals with SCI and their caregivers about strategies to prevent PIs and minimize risk by improving and/or maintaining basic health factors. Identification of PIs early and seeking appropriate medical care without delay will allow immediate intervention, prevention of worsening, and treatment of infection if present.

2.11 Quality of Life

Panel Findings

- Health-related QOL reflects psychological functioning, in particular the extent to which an individual comes to view the consequences of SCI as not devaluing one's sense of self and opportunities to find meaning and purpose.
- Injury level and severity are weakly and inconsistently associated with health-related QOL. However, individuals with more severe injuries are at increased risk of developing secondary conditions, particularly pain, which can adversely affect health-related QOL.
- Environmental factors, including social support, activities of daily living assistance, access to resources, policies, and the attitudinal and built environments, can affect health-related QOL. Greater social support and access to resources increases opportunities for engagement in valued activities and consequently better health-related QOL.
- Modifiable factors, in particular education, provide more opportunities for employment, greater income, and social participation and subsequently improved health-related QOL.

Synopsis of Evidence

Individuals with SCI can experience good QOL despite limitations in independent living, employment, and social relationships (Aaby et al., 2020). One large study reported that higher QOL was associated with lower injury levels (T7-S5), educational enrollment, independent living, and lower incidence of past medical problems (Chen et al., 2008). Acceptance of SCI was positively associated with global, physical, psychological, and social QOL, whereas acceptance was negatively associated with depressive symptoms and anxiety (Sauri et al., 2014; Elfström et al., 2005). Many individuals maintain good or excellent QOL over time as they adapt to changes in their lives (Sakakibara et al., 2012).

Most studies with large samples report no relationship between injury severity and QOL (Anderson et al., 2004; Charlifue et al., 1998; Vogel et al., 2002). One study reported greater life satisfaction for individuals with T7-S5 injuries than with higher injury levels, but these individuals were also more likely to report employment and have greater social participation (Chen et al., 2008). Only 1 large study (Charlifue et al., 1998) reported that life satisfaction decreased over time for individuals with complete paraplegia. Individuals with SCI who have at least a baccalaureate degree report higher life satisfaction than do those with less education (Anderson et al., 2004; Chen et al., 2008). Individuals with SCI who are employed and consequently have higher incomes report greater life satisfaction and less emotional distress than do unemployed persons (Greenham et al., 2020).

Physical activity is consistently associated with better quality of life after SCI. A systematic review that included 20 studies found strong evidence that leisure-time physical activity was positively associated with both subjective and objective measures of quality of life. Benefits were observed across physical, psychological, and social domains, with the strongest effects seen in self-reported well-being (Tomasone et al 2013, n=3114).

Recommendations

2.11.1 We recommend baseline assessment and periodic monitoring of health-related QOL, using standardized assessments that have robust psychometric properties when used in individuals with SCI (1D).

2.11.2 We recommend that individuals with SCI who have poor health-related QOL be referred to clinicians who are skilled at addressing behavioral health needs and limitations in physical functioning, as well as to community resources to improve vocational, economic, and social well-being (1D).

2.11.3 We recommend that clinicians monitor for abuse, neglect, and violence by using disability-specific measures and, if detected, provide appropriate reporting, resources, and referrals (1D).

2.11.4 We recommend that interventions focus on modifiable factors that may influence health-related QOL, including encouraging regular physical activity consistent with evidence-based exercise guidelines for adults with SCI (1D).

2.11.5 We recommend that clinicians be aware that individuals with SCI can have a high health-related QOL and that they promote this expectation to their patients (1D).

Rationale

Consistent biopsychosocial predictors of QOL in individuals with SCI are supported by large studies. These studies indicate that health-related QOL is

associated with social support (Elfström et al., 2005) and physical functioning (Rivers et al., 2018). Physical activity is strongly associated with better quality of life after SCI, with evidence showing that leisure time activity improves subjective and objective outcomes across physical, psychological, and social domains, most notably in self reported well being (Tomasone et al., 2013; n=3114). Evidence-based exercise guidelines provide a foundation for developing exercise policies and programs for individuals with SCI worldwide (Martin Ginis et al., 2018).

Health-related QOL is a major focus of the psychosocial literature, reflecting an appreciation of the emphasis on activity and participation in the World Health Organization's (2001) *International Classification of Functioning, Disability and Health*. Multiple psychological, social, health, and environmental factors influence health-related QOL, many of which are amenable to interventions by medical, allied health, behavioral health, and vocational rehabilitation professionals. Locus of control is strongly associated with health-related QOL (Boschen et al., 2003).

Individuals with SCI, particularly women, seem to experience higher rates of interpersonal violence than do adults without SCI or other disabilities. Surveys of women with SCI (Robinson-Whalen et al., 2022, n=175) have found that 55% had experienced some abuse in their lifetime, with 43% reporting physical abuse, 32% reporting sexual abuse, 23% reporting disability-related abuse, and 16% reporting all 3 (physical, sexual, disability) types of abuse. Disability characteristics were associated with disability-related intimate partner violence victimization, and women with SCI with a history of interpersonal violence had poorer self-reported health and greater depression. Screening for interpersonal violence should also occur for both women (Robinson-Whelen et al., 2022) and men with SCI.

2.12 Community Participation (including participation in school or employment)

Panel Findings

- Community reintegration among individuals with SCI is influenced by the interaction between injury-related, personal, and socioenvironmental factors. In general, the greater the severity and the higher the level of injury, the more important the role of personal and socioenvironmental factors, with higher income, education, social support, and insurance coverage identified as being particularly influential.
- Secondary health conditions, including psychological conditions, are barriers to community participation. Psychological factors play a key role in community participation and integration for individuals with SCI. Self-efficacy and self-esteem facilitate community reintegration, whereas the presence of psychological complications, including symptoms of depression and anxiety, appears to decrease it.
- Resources and social support are both positively associated with community integration, and the built and attitudinal environments can serve to either facilitate or limit community participation for individuals with SCI.
- Many individuals become employed or return to school at some point after SCI; however, time until employment and ability to sustain and advance in jobs varies significantly. Employment is more likely for those who can return to their previous employer and for those whose employment did not involve physical labor; consequently, history of employment and employment type prior to injury influences employment outcomes after SCI.
- Education increases the likelihood of employment after SCI, and education level is a strong independent predictor of paid employment after SCI. Other key predictors of employment after SCI include severity of injury (greater likelihood for individuals with less severe injuries), age at injury (younger), driving status (positive), and socioenvironmental factors (greater support, access to transportation).
- Although race and ethnicity have been related to employment outcomes after SCI, findings are likely to reflect differential knowledge of and opportunities for employment that interact with socioeconomic and environmental factors and serve as additional barriers for individuals of racially and ethnically marginalized communities.

Synopsis of Evidence

<u>Biopsychosocial Characteristics and Community Participation</u>. Research about community participation after SCI indicates that neurological classification and personal demographics alone are inadequate predictors of community reintegration (Whiteneck et al., 1999, n=3,835). Instead, there is an interaction between injury-related, personal, and socioenvironmental factors. An integrative review of 49 studies concluded that there is not a direct relationship between injury characteristics and community participation (Gupta et al., 2019, n=49). Likewise, other studies have found that although SCI level and severity are good predictors of functional performance, neither predicts community integration (Anderson et al., 2003, n=216; Whiteneck et al., 2004, n=2,726).

Time since injury is also inconsistently associated with community integration (Gupta et al., 2019), although evidence exists that physical independence, mobility, and participation improve the longer someone lives with SCI (Whiteneck et al., 1999). The evidence is also mixed related to sex and community reintegration. Anderson et al. (2003, n=216) concluded that sex/gender was not associated with community integration; in contrast, another study reported significant sex differences on the occupation dimension of CHART, an index of the degree to which impairments result in handicap (Whiteneck et al., 1999, n=3,835). It seems likely that sex/gender may influence the types of activities or participation that are more valued, with men often giving more importance to employment and women finding greater value in family activities.

Access to resources, including income, insurance coverage, education, and employment are consistently reported to have a positive impact on community participation. Studies consistently report that higher income, being employed, higher education, and insurance coverage at time of injury had positive effects on community reintegration (Anderson et al., 2003, n=216; Barclay et al., 2015, n=23 studies; Tonack et al., 2008, n=781). Carr et al. (2017, n=270) identified employment as the strongest independent factor positively associated with community participation because it regularly placed individuals in the community and motivated them to participate with a sense of purpose. Finally, most systematic reviews show that social networks and relationships with family are critical for community reintegration after SCI (Barclay et al., 2015; Gupta et al., 2019; Kashif et al., 2019, n=11). Social support not only improves participation, but it helps individuals with SCI cope with secondary health conditions and overall management of life with SCI (Gupta et al., 2019).

<u>Participation in School or Employment</u>. Reported rates of participation in employment after SCI vary greatly, with rates ranging from 3% to 80% (Ottomanelli and Lind, 2009, n=60). The actual employment rate is likely to vary between 35% and 47% at some point after SCI (Trenaman et al., 2015; Hwang et al., 2015; n=461; Franceschini et al., 2012, n=403). Injury level is associated with employment such that individuals with tetraplegia were more often unemployed or in school 1 year after injury than were those with lower spinal lesions (Franceschini et al., 2012, n=403; Ozelie et al., 2012, n=1,032). However, injury level may interact with other factors to influence long-term employment outcomes. With increasing age, employment declines. Trenaman et al.'s (2015) systematic review reported that a 1-year increase in age was associated with a 2-4% decrease in the odds of employment. In a Dutch study (Tomassen et al., 2000), successful return to gainful employment was most likely for men, those with higher educational levels, higher functional status, and for those who participated in post-injury retraining; the physical intensity pre-injury occupation was a key predictor, as individuals with light to moderate physical jobs were more than three times as likely to return to work compared to those with heavy or strenuous positions.

At 5 years after injury, approximately one-third of adults with SCI are either working, in school, or both (Franceschini et al., 2012). The average time until the first job is 3.9±3.6 years; however, employment after SCI appears to happen sooner for those with an employment history who are returning to work with the same employer after injury in comparison to those with SCI who have to find new employment or those without a work history. In addition, variation in time until employment after SCI seems to exist between injury severity groups, ranging from a low of 1.7 years for those with thoracic and lumbar injuries to a high of 3.8 years for those with C5-C8 injuries (Krause et al., 2010, n=1,134). Other literature shows 348.3±220.0 days as the average time to first employment, in which approximately 25% of first jobs were obtained within 4-6 months (Ottomanelli et al., 2017, n=213). Of those who were employed, the majority appeared to work full time (Hwang et al., 2015, n=461).

The evidence consistently shows that education is independently associated with employment outcomes after SCI (Trenaman et al., 2015, n=39 studies). Higher

preinjury education favors employment (Tomassen et al., 2000); individuals with only a primary-school education are least likely to be employed after SCI (19% in 1 study), whereas those with postsecondary education (university, college) have 2.5 to 26 times the rate of paid employment after SCI (Tomassen et al., 2000; Ozelie et al., 2012; Pflaum et al., 2006, n=20,143). Likewise, among those who had been white-collar workers, 73.3% returned to work, whereas 32.9% of those who had been blue-collar workers did so (Van Velzen et al., 2012, n=103). Individuals with SCI who have higher levels of education have increased options and are less likely to obtain manual labor jobs, increasing rates of successful employment (Ottomanelli and Lind, 2009, n=60 studies). Beyond preinjury education level, post-injury education was also associated with increased employment rates for individuals with SCI (Krause, 2003, n=259; Tomassen et al., 2000).

Mixed findings have been reported for the relationship between employment and both sex and marital status. In particular, although some studies have noted a higher proportion of paid employment among men (Trenaman et al., 2015; Tomassen et al., 2000), this relationship is not consistently found (Hess et al., 2000, n=3,175; Hwang et al., 2015). The research also suggests that marital and parenting status may be related to employment, with results suggesting that individuals with SCI who are married (Hwang et al., 2015; Pflaum et al., 2006; Arango-Lasprilla et al., 2009, n=1,528; Hess et al., 2000; Botticello et al., 2012) or have children under 18 living in their home (Hess et al., 2000) are more likely to be employed, possibly reflecting an over-representation of employed adults with SCI who are in relationships or that community participation, including employment, is seen as an important aspect of being a role model for their children.

Recommendations

2.12.1 We recommend that clinicians work with individuals with SCI and their social networks to identify and address modifiable factors that influence community participation and facilitate their optimization, including education, psychological health, social support, and the built environment (1C).

2.12.2 We recommend that individuals with SCI become engaged with rehabilitation professionals, social workers, peer mentors, and community organizations to facilitate awareness of and access to resources and social support, as well as opportunities for adaptive physical and recreational activities (1C).

2.12.3 We recommend that clinicians with appropriate training evaluate home, community, school, and work environments for ease of use and modifications to enhance access, safety, and independence of individuals with SCI (1C).

2.12.4 We recommend that social workers or counselors assess the interest of individuals with SCI in education and facilitate referrals and supports for the completion of secondary, undergraduate, and graduate degrees (1B).

2.12.5 We recommend that clinicians encourage individuals with SCI to engage with peer mentors and offices of Disability Support Services in postsecondary environments to facilitate disability accommodations and supports (1D).

2.12.6 We recommend that health care systems integrate vocational rehabilitation counselors as part of the multidisciplinary SCI health care team. When this is not feasible, we recommend that clinicians refer the individual with SCI to vocational counseling and vocational rehabilitation services, as well as relevant community resources (1B).

2.12.7 We recommend that individuals with SCI have access to employment-related planning and resources that center around their specific skills, functional capabilities, interests, and concerns (1C).

2.12.8 We recommend that individuals with SCI be provided with support to facilitate the completion of the activities of daily living required to prepare for and participate in employment activities, including those associated with management of health in employment environments (1C).

Rationale

There is consistent evidence that secondary health conditions serve as a barrier to community participation and that, more specifically, participation is reduced by pressure injuries, neurogenic bladder, UTI, spasticity, pain, contracture, tightness, and sleep problems (Kashif et al., 2019, n= 11 studies; Tonack et al., 2008, n=2,839). Management and prevention of secondary and chronic conditions is critical to obtaining and retaining employment.

Psychological factors also play a key role in community participation and integration for individuals with SCI. Depressive symptoms appear to decrease the likelihood of being employed (Trenaman et al., 2015; Burns et al., 2010, n=83; Lin et al., 2009, n=219). A review by Gupta et al. (2019) concluded that there is level 1 evidence that self-efficacy and self-esteem facilitate community reintegration (from at least 8 studies), and there is level 5 evidence that the presence of psychological complications decreases it (from at least 5 studies). Findings from small studies have suggested that better social support is associated with slightly increased odds of employment (Trenaman et al., 2015; Burns et al., 2010, n=83). Therefore, appropriate referral for psychological evaluation and services from rehabilitation psychologists or others with appropriate training are recommended in order to facilitate participation and employment outcomes.

Evaluation and modification of the built environments and mobility-related training are important for enhancing community participation and employment. Numerous systematic reviews report that lack of accessible transportation, as well as barriers in architecture and natural environments, prevent the SCI community from fully participating and reintegrating in the community (Barclay et al., 2015, n=23 studies; Gupta et al., 2019; Kashif et al., 2019); perceived access-related barriers have been associated with lower odds of employment (Conroy and McKenna, 1999, n=440; Burns et al., 2010). Research suggests that environmental barriers may produce a sense of discrimination and decrease social participation, making it more difficult for individuals with SCI to adjust to change, especially if they are using a wheelchair (Kashif et al., 2019). In contrast, wheelchair skills are significantly associated with employment (van Velzen et al., 2012) and being able to drive seems to increase the likelihood of employment by almost 2 times compared with not being able to do so after SCI (Norweg et al., 2011, n=3,726).

Evidence from a systematic review that included 39 studies identified 5 modifiable factors that are consistently linked to employment outcomes, including education, vocational rehabilitation, functional independence, social support, and financial disincentives (Trenaman et al., 2015). In particular, post-injury education and vocational training, retraining, and vocational counselling have been associated with increased rates of employment. Arango-Lasprilla et al. (2011, n=4,514) found that a variety of vocational rehabilitation services, including education, on-the-job training, job search assistance, job placement assistance, on-the-job support, maintenance services, and assistive technology services, predicted successful employment outcomes for individuals with SCI.

Employment interventions based on principles of supported employment have the strongest research support for enhancing competitive employment for adults with SCI. The Spinal Cord Injury Vocational Integration Program was a randomized clinical trial that integrated vocational rehabilitation counselors with responsibility for implementing and coordinating vocational rehabilitation services into the health care continuum for veterans with SCI (Ottomanelli et al., 2012, 2013, n=201). Specific responsibilities and activities included personalized benefits counseling, rapid engagement and assistance with job finding based on the client's preferences, and personalized support and connections to community-based services. The results showed improvements in the employment rate, increases in the number of hours worked, and decreases in the number of missed hours of work (Ottomanelli et al., 2012, 2013) at both 1 and 2 years after baseline in comparison to both usual service and observational control sites.

Some evidence also shows that receipt and use of a trained service dog is associated with enhanced community participation and school- and employment-related outcomes for wheelchair users, including individuals with SCI (Allen and Blascovich, 1996).

Section 3: Outcome Modifiers

(Correlations Identified in the Literature)

3.1 Societal Attitudinal Factors

Panel Findings

- African American adults with SCI with both private and public insurance experience worse health outcomes, including higher rates and earlier onset of cardiometabolic, musculoskeletal, and psychological conditions than do non-Hispanic White adults with SCI.
- Individuals with SCI from racially and ethnically marginalized communities are negatively affected by systematic racism, which reduces economic and social resources, as well as by stereotypes, prejudice, and implicit bias, which reduce health care quality and negatively affect health outcomes.
- Health care providers, including physiatrists and clinicians who regularly work with individuals with SCI, display both ableism and racist bias.
- Implicit and systematic bias associated with disability (e.g., ableism) appears to limit access to and quality of health care services for individuals with SCI, those from marginalized communities based on race, ethnicity, sex, and sexual orientation being most at risk.

Synopsis of Evidence

Differences in health outcomes linked to racial and ethnic backgrounds are influenced by social determinants of health and are shaped by implicit bias and systemic racism. Race and ethnicity are social, constructs, not biological constructs. Structural racism operates through societal systems that sustain racial discrimination, reinforcing inequitable beliefs, values, and distribution of resources (Bailey et al., 2017). Thus, the disproportionate coverage of African Americans and other individuals of color under Medicaid is not just a representation of racial disparities and social determinants of health, but it also reflects institutionalized and systematic racism.

Evidence indicates that individuals with SCI who are from racial and ethnic minority backgrounds are more likely to have sustained SCI as a result of violence (Burnett et al., 2002) and are more likely to be uninsured or covered by Medicaid rather than by private insurance. They are also more likely to experience a greater number of negative social determinants of health, including preinjury rates of limited education, low income, and employment, than are non-Hispanic White individuals with SCI. Moreover, individuals with SCI from racial and ethnically marginalized communities, as well as those with Medicaid as a primary payer, are less likely to receive inpatient rehabilitation after acute hospitalization than are individuals from nonminority backgrounds (Myaskovsky et al., 2011, n=275).

Research from large studies shows that African Americans with SCI experience higher rates of complications and secondary conditions during and after hospitalization (Burnett et al., 2002, n=4,176) than do non-Hispanic White individuals with SCI. African Americans with SCI also have higher rates of days reported to be in poor health, more hospitalizations, and more days hospitalized (Mahmoudi et al., 2014, n=5,146; Krause et al., 2006, n=1,342). Moreover, clinicians were less likely to routinely assess for pain in individuals with SCI from racial and ethnic marginalized communities than in individuals from nonmarginalized communities. In addition, women and individuals with SCI from racial and ethnic minority communities were more likely to report inadequate pain management and higher levels of pain interference than were non-Hispanic White men with SCI (Cardenas et al., 2004a).

More recently, research has identified strong pro-White or anti-Black bias among physicians who work with individuals with SCI (Hausmann et al., 2015, n=162 individuals with SCI and n=14 physicians). Notably, the research showed an association between greater physician bias and lower rates of social integration and life satisfaction, as well as higher rates of depression. Other research identified significant ableist biases among physicians. In their survey of US physicians, Iezzonni et al. (2021; n=714) found that 82.4% reported that individuals with significant disability have worse QOL than nondisabled individuals do, 40.7% reported being very confident about their ability to provide the same quality of care to patients with disability, and only 56.5% strongly agreed that they welcomed patients with disability into their practices. Moreover, it appears that physicians have little knowledge about the Americans with Disabilities Act (ADA) or about their legal obligations toward individuals with disabilities (Agaronnik et al., 2019).

Although limited research exists on individuals with SCI who identify as LGBTQ+, the available studies highlight the role of implicit bias in limiting access and quality of care. In a survey of 402 providers of rehabilitation services, 79% reported that they have never considered that individuals with SCI could be LGBT (Burch et al., 2008). These findings are consistent with a case report describing how the identification of SCI in a transgender female with new-onset paralysis and pain was initially misdiagnosed as conversion disorder by physicians in trauma, neurology, physical therapy, and psychiatry services (Williams, 2012).

Recommendations

3.1.1 We recommend that clinicians critically evaluate their health care processes for personal and systemic biases that affect both access to and the quality of care provided to individuals with SCI on the basis of, for example, gender, race, ethnicity, sexual orientation, education, weight, religion, age, and disability (1C).

3.1.2 We recommend that clinicians participate in implicit bias training to identify their own areas of unconscious bias and take steps to challenge assumptions perpetuated through systemic processes based on, for example, race, ethnicity, gender, disability, religion, and sexual orientation (1D).

3.1.3 We suggest that clinicians be knowledgeable about their legal responsibilities toward individuals with SCI and other disabilities, as identified through the Americans with Disabilities Act (ADA), Section 1557 of the Affordable Care Act, and other federal policies and statutes (2D).

3.1.4 We recommend the collection of data about, for example, race, ethnicity, and sexual orientation based on self-report rather than by assumptions or information from the medical record (1D).

3.1.5 We recommend assessment of health literacy and documentation of the patient's proficiency in speaking and writing English, as well as the preferred spoken language needed for effective communication with health care providers, including appropriate accommodations (1D).

Rationale

The Institute of Medicine report *Unequal Treatment* (2003) highlighted the influence of stereotyping and prejudice on the interpretation of data and the types of interventions that are provided, therefore leading to racially disparate clinical decisions and outcomes. Implicit bias, unrecognized prejudice, discrimination, and bias by health care providers have been assessed and associated with lower quality of health care (Fitzgerald and Hurtz, 2017), as well as negative health care outcomes and health care disparities. These widely accepted interdisciplinary reports are critical for interpreting findings associated with marginalized populations of individuals with SCI, including marginalization as defined or identified by race, ethnicity, sex, and sexual orientation.

Evidence-based recommendations from the National Academies of Health (Institute of Medicine, 2003; National Academies of Sciences, Engineering, and Medicine, 2017) should be used to provide guidance related to identifying and reducing health and health care disparities. These recommendations should be integrated with diagnostic-specific knowledge about SCI and the evidence-based research about marginalized populations to tailor care so as to enhance outcomes while also monitoring for health and health care disparities. In particular, awareness of the role of systematic racism and how it has led to reduced resources and opportunities for individuals from racial and ethnically marginalized communities is important.

Implicit bias training can increase general awareness about disparities with best practices. At the individual level, providers can work to identify their own biases and knowledge gaps associated with socioeconomic status (SES) and adapt their practices and decision making appropriately. Systematic reviews (Fitzgerald and Hurtz, 2017) show that implicit biases are as common among health care providers as the general population and as reactive to multiple patient characteristics. Implicit bias by health care providers

influences diagnosis and decision making, as well as access to resources and treatment (Fitzgerald and Hurtz, 2017).

3.2 Environmental Factors

Panel Findings

- Inaccessibility of the built environment is identified as a primary barrier to community participation for individuals with SCI, whereas accessible environments support social participation and meaningful activities.
- The built environment in both the home and community significantly influences outcomes for individuals with SCI; greater barriers are associated with decreased rates of social participation and more negative health outcomes.
- Individuals with SCI, particularly those from economically marginalized communities, living in communities with more open space and less heterogeneity of land use report better perceived health.

Synopsis of Evidence

Research has shown that the built environment in both the home and community can significantly affect outcomes for individuals with SCI. Barclay et al. (2015) reviewed 23 studies of participants with SCI and found that inaccessibility of the built environment is identified as a primary barrier to community participation. Specifically, inability to access other individuals' homes is a barrier to social participation (Boschen et al., 2003; Price et al., 2011), whereas accessible environments appear to support engagement in important and meaningful activities (Ripat and Woodgate, 2012). More recently, Tate et al. (2023, n=183) found that ramps (54.4%) and bathroom equipment (62.6%) were particularly important in enabling adults aging with SCI to participate in the home environment, and curb cuts (54.9%), elevators (58.8%), and paved surfaces (63.7%) helped participation in the community. Regarding community features, Botticello et al. (2015) found that living in a community with greater heterogeneity of land use was associated with poorer perceived health for individuals with SCI. In contrast, persons living in a community with more open space were less likely to report poor health; however, this relationship was mitigated by differences in individual background, impairment severity, and SES.

Recommendations

3.2.1 We recommend the evaluation and modification of home, outdoor, and workplace environments as needed to enhance access, independence, and participation for individuals with SCI (1C).

Rationale

The *International Classification of Functioning, Impairment and Disability* (WHO, 2001) identifies environmental factors, including factors in the natural and built environments, as being influential in their impact on the functional abilities and participation of individuals with disabilities, including adults with SCI. The more severe the impairment, the greater the impact of the environmental factors and the greater the potential benefit of accessibility features.

Home assessments for individuals with SCI used to be a standard of care by occupational therapists prior to individuals' discharge from inpatient rehabilitation; however, decreased lengths of stay and increased therapeutic demands have made these assessments less common. Although no studies could be found to identify the effectiveness for enhancing outcomes for individuals with SCI, research with other populations has noted their effectiveness in reducing falls; however, the costs and time demands associated with such treatments are also noted (Johnston et al., 2010). More recently, virtual and mobile health (mHealth) technologies have been developed to enhance a therapist's ability to implement environmental assessment from a distance; uptake has, however, been limited (Nix and Comans, 2017).

Research with individuals with SCI has repeatedly noted the negative association between perceived environmental barriers, health, and participation, with greater barriers linked with more negative outcomes (Gurung et al., 2023; Tsai et al., 2017). In contrast, greater accessibility in both home and outdoor environments is linked with enhanced autonomy and family roles for adults with SCI (Norin et al., 2017, n=123). Moreover, a systematic review on the impact of home environments for individuals with functional limitations found that the lack accessibility modifications adds to the individual's limitations and that interventions to enhance the accessibility of homes can have positive effects (Cho et al., 2016).

3.3 Spasticity

Panel Findings

- Spasticity is a common secondary condition after SCI. Although most individuals with SCI have spasticity, it is not always detrimental or predictable, and it may affect muscles across different joints to varying degrees. Spasticity evolves over time (Hsieh et al., 2019).
- Problematic or disabling spasticity is defined as spasticity that is perceived by the individual or caregivers as hindering body function, activities, and/or participation.
- Problematic spasticity is more prevalent with cervical-level injury and incomplete injuries.
- The most problematic aspects of spasticity are stiffness all day, interference with sleep, painful spasms, perceived link between spasticity and pain, and intensification of pain before a spasm (Field-Fote et al., 2022).
- The stiffness associated with spasticity is reported to have a more negative impact on daily activities than spasms do.

Synopsis of Evidence

The prevalence of spasticity following SCI is most often reported as 65% in individuals with SCI, although some reports are as high as 86%-93% (Harrington and Bockenek, 2011; Adams and Hicks, 2005; Holtz et al., 2017; DiPiro et al., 2018). During inpatient rehabilitation, prevalence is lower than in the chronic population, affecting only 25%-37% of individuals with traumatic SCI and 15%-36% of individuals with nontraumatic SCI (Joseph et al., 2009, n=357). Spasticity during acute phase rehabilitation is associated with worse functional recovery (Milicevic et al., 2014).

In a study of 482 individuals with SCI who had been hospitalized in the prior year, spasticity was cited as the fourth leading reason for hospitalization (Noreau et al., 2000). Approximately 35% of individuals with chronic SCI experience problematic spasticity, with 11%-14% considered moderate to severe (Holtz et al., 2017). Problematic spasticity is more prevalent in those with tetraplegia and in incomplete injuries with spared sensation and motor activity below the level of injury (Adams and Hicks, 2005; Andresen et al., 2016; Holtz et al., 2017).

A large survey with 1,079 respondents reported the stiffness associated with spasticity as having a greater negative effect on daily activities than spasms do. The most problematic aspects of spasticity were reported to be stiffness all day, interference with sleep, painful spasms, perceived link between spasticity and pain, and intensification of pain before a spasm (Field-Fote et al., 2022). Although there were a few activities of daily living that respondents reported were helped by spasticity (i.e., changing position in bed, dressing, transferring), only 7%-9% of the 1,076 participants reported spasticity to be helpful.

Despite the negative influence of spasticity on daily activities reported by individuals with SCI and its association with hospitalizations, the involuntary muscle activity associated with spasticity appears to have some benefits. In a study of 69 participants with SCI (66.7% with tetraplegia, 33.3% with paraplegia), scores on clinical and self-report scales of spasticity were found to be significantly associated with lower extremity muscle mass index (Cha et al., 2019). In addition, a study of 10 men with SCI found that spasticity appears to have beneficial effects on body composition and metabolic profile, and therefore may indirectly influence glucose homeostasis and lipid profile by helping to maintain fat-free mass (Gorgey et al., 2010).

Recommendations

3.3.1 We recommend screening for problematic spasticity at regular intervals and that individuals with positive results undergo more detailed assessment, including identification of possible extrinsic causes (1B).

3.3.2 We recommend that the impact of problematic spasticity on comfort, functional activities, independence, burden of care, and QOL be evaluated and addressed (1B).

3.3.3 We recommend providing education on integrating nonpharmacological spasticity management options, such as stretching, exercise, and activity, into daily activities to improve comfort and QOL (1C).

3.3.4 We recommend that clinicians document the impact of spasticity by using standardized assessment before and after therapeutic interventions (1B).

Rationale
Although antispasmodic medications are considered the first line of treatment for spasticity, many individuals with SCI report that their spasticity is more effectively managed with stretching, exercise, and physical activity (Field-Fote et al., 2022). In addition, evidence from numerous small randomized studies shows that other accessible physical therapeutic interventions such as stretching, transcutaneous electrical nerve stimulation, FES, whole-body vibration and stimulation, and transcutaneous spinal stimulation also have benefit for reducing spasticity (Ness and Field-Fote, 2009; Estes et al., 2017, n=10; Estes et al., 2018, n=35; Sandler et al., 2021, n=32; Hofstoetter et al., 2020, n=12; Sivaramakrishnan et al., 2018, n=10). While acknowledging the mostly negative influence that problematic spasticity has on daily functional activities, it is important to advise individuals with SCI that spasticity can have some beneficial effects when performing functional activities like dressing and transferring (Field-Fote et al., 2022. In addition, spasticity can help preserve muscle mass (Cha et al., 2019), and has beneficial effects on body composition and metabolism (Gorgey et al., 2010).

There is currently significant heterogeneity and inconsistency among the outcome measures used to assess changes in spasticity in human trials. Given the prevalence, more research is needed to determine whether it is possible to prevent the development of problematic spasticity in the early period of SCI (Stampas et al., 2022). Additionally, acrorss clinical practice, rehabilitation research, and regulatory contexts such as the FDA there is an overreliance on the Modified Ashworth Scale, which lacks consistent reliability and does not capture the full breadth of the spasticity experience (Fleuren et al. 2010; Gal et al., 2025; Apinkar et al., 2017).

3.4 Pain

Panel Findings
- Chronic pain is one of the more common secondary conditions affecting individuals with SCI and includes neuropathic and nonneuropathic (e.g., musculoskeletal) types.
- Chronic pain has adverse effects on functioning in the following areas: home, work, and therapy participation. Chronic pain is associated with worse psychological functioning and worse sleep.
- There is conflicting evidence regarding how pain interacts with sex and race to influence outcomes. Little information is available on sex, ethnicity, or race disparities in relation to access to SCI-related pain treatment.

Synopsis of Evidence
A systematic review of 82 studies reported that chronic pain affects an estimated 61% of individuals with SCI (van Gorp et al., 2015). The 2 most common types of SCI-related pain are neuropathic and musculoskeletal. The pooled prevalence of neuropathic pain was 58% from 13 studies, and the pooled prevalence of musculoskeletal pain was 56% from 11 studies (Hunt et al., 2021). Greater below-lesion level neuropathic pain was associated with tetraplegia, older age, and being > 1 year after SCI in a meta-analysis of 17 studies (Burke et al., 2017). A 16-site study (n=7,379) reported that pain interference is higher among individuals with paraplegia, incomplete SCI, and those who are unemployed (Cardenas et al., 2004a).

Chronic pain interferes with how much individuals with SCI participate in life in the home, vocationally, and in rehabilitation therapies. For example, 2 small studies (n=259-265) showed that musculoskeletal pain is related to restricted functioning at home and work (Miro et al., 2014; Roels et al., 2018). Among 1,357 participants, severe pain was related to missing more hours of physical therapy, attending fewer hours of occupational therapy, and spending fewer days in inpatient rehabilitation relative to those with lower pain levels (Zanca et al., 2013). Pain is negatively related to psychological functioning (Miro et al., 2014). In addition, small studies have reported that pain in individuals with tetraplegia (vs. paraplegia) and continuous pain (vs. intermittent pain) are related to having poorer sleep (Norrbrink et al., 2005; January et al., 2017).

Conflicting research results have been reported on the interaction of pain prevalence, pain severity, and pain interference with sex and race. A study with over 7,000 participants found that individuals of color report greater pain interference than White individuals do, and women report greater pain interference than men do (Cardenas et al., 2004a). Yet smaller studies reached different conclusions, finding no significant difference in pain intensity by race (Saunders et al., 2013, n=2,416; Stampacchia et al., 2022, n=385) and no differences in pain prevalence between men and women with SCI (Stampacchia et al., 2022).

Recommendations
3.4.1 We recommend that health care providers use current clinical practice guidelines (CPGs) to treat SCI-related pain, in part because treating pain can improve physical and psychological functioning (1A).

3.4.2 We recommend that clinicians use standardized measures to assess pain, including pain intensity and pain interference with physical and psychological functioning such as sleep and mood (1C).

Rationale
The Canadian SCI pain guidelines recommend that "standardized evaluation of treatment response should be carried out by the healthcare team at regular intervals" and that "the evaluation of treatment response should include assessment of changes in pain intensity, mood and function using the International Spinal Cord Injury Pain Basic Data Set v2.0" (Widerstrom-Noga et al., 2008; Loh et al., 2016; Mehta et al., 2016) or the Neuropathic Pain Special Interest Group guidelines on neuropathic pain assessment (Haanpaa et al., 2011). Evidence suggests that treating chronic pain may improve aspects of physical and psychological functioning. A meta-analysis of 8 studies showed that gabapentinoids reduced pain interference with sleep, anxiety, and depression (Mehta et al., 2014). A review of 2 small RCTs (n=172, n=181) concluded that gabapentinoids improve sleep and pain interference. Alternative treatments such as cognitive behavioral therapy and transcranial direct current stimulation may also reduce pain interference (Loh et al., 2022).

Although the literature related to the general population indicates that access to pain management may differ in some racial and ethnic groups, currently no information is available on differences in access to pain management attributable to sex, ethnicity, or race in individuals with SCI.

3.5 Bone Density

Panel Findings
- Individuals with SCI typically have significant bone loss primarily in the first few years and throughout their lifetime.
- As a result of bone loss, individuals with SCI are at high risk for fragility fractures. These fractures are strongly associated with complete motor SCI, paraplegia, increasing age, and > 10 years after SCI. Other risk factors include being female and family history of fractures for men.
- Fragility fractures in individuals with SCI typically occur in the distal femur and proximal tibia, mostly as a result of transfers and falls.
- Fragility fractures of the hip, distal femur, and proximal tibia regions are associated with increased morbidity.
- Fragility fractures in the lower extremities are associated with increased mortality in individuals with SCI who have complete SCI and who are older.

Synopsis of Evidence
Bone loss typically occurs in individuals with SCI, particularly in the first 2 years after injury; most bone densitometry values are significantly lower in the SCI group compared with reference groups, including total bone mineral density (BMD) at the distal tibial epiphysis (-58.0% in women with SCI and -53.6% in men with SCI, p<0.033; Frotzler et al., 2020, n=163, 43 with SCI).

Fragility fractures are an injury type that occurs after a fall from standing or seated height or less, or in the absence of trauma such as during routine activities of daily living. Research suggests that 20%-46% of individuals with SCI will experience a fracture during their lifetime (Ashe et al., 2007, n=113 total in controlled studies; Morse et al., 2016, n=152). The majority of fragility fractures after SCI occur in the distal femur and proximal tibia regions, and the most frequently reported mechanisms of fracture in the SCI population include transfers or falls (Frotzler et al., 2020, n=163, 43 with SCI; Grassner et al., 2018, n=132; Morse et al., 2009, n=315). Nelson et al. (2010, n=702) reported that fractures occurred in 18% of falls in wheelchair users and that a history of falls, higher motor function, pain in the previous 2 months, and/or an inaccessible home entrance explained 81% of the variance for falls that caused injury in individuals with SCI. Low bone mass and elevated fracture risk are not typically problematic until a fragility fracture occurs; however, fragility fractures of the hip, distal femur, and proximal tibia regions are associated with increased morbidity (PIs, UTIs, respiratory infections,

thromboembolic events, depression, and delirium; Carbone et al., 2013, n=2,054, p<0.03) and mortality (Carbone et al., 2014, n=12,389, hazard ratio [HR] 1.32-1.46). See Figure 1.

There are a number of established predictors and risk factors for fragility fractures in individuals with SCI. The largest study that investigated fracture risk in individuals with SCI (Bethel et al., 2016, n=22,516) found that the 3 highest predictors for fracture were history of hip fracture 1 year prior (HR 4.08), opioid use (HR 1.36), and complete SCI (HR 1.34). See Figure 2. Studies have shown that fragility fractures are strongly associated with complete motor SCI (AIS A or B) and paraplegia (Pelletier et al., 2014, n=1,137; Vestergaard et al., 1998, n= 438 with SCI). Fragility fractures are also significantly associated with SCI duration of > 1 year (Hammond et al., 2014, n=364), increasing age, and > 10 years after injury (Pelletier et al., 2014; Garland et al., 2004, n=152; Garland et al., 2005, n=168; Carbone et al., 2014, n=12,389; Cirnigliaro et al., 2020, n=105). Other research results on risk factors point to women with SCI requiring special attention regarding osteoporosis, menses, and being postmenopausal (Pelletier et al., 2014; Vestergaard et al., 1998; Garland et al., 2004). Male patients who have a family history of fractures are at increased risk for fragility fractures (Vestergaard et al., 1998).

In a cohort of 315 veterans surveyed within 1 year of injury, fracture-related complications occurred in 53%. Independent risk factors for admission to hospital were motor-complete vs. motor-incomplete SCI (Morse et al., 2009, n=315). In another study, lower extremity fracture associated with increased mortality was substantially greater in older men (age ≥ 50 years) for the entire cohort (HR 3.42, 95% CI 2.75-4.25) and for those with complete SCI (HR 3.13, 95% CI 2.19-4.45) than it was in younger men (age <50 years) (entire cohort: HR 1.42, 95% CI 0.94-2.14; complete SCI: HR 1.71, 95% CI 0.98-3.01; Carbone et al., 2014, n=12,389 men only).

The *Consortium for Spinal Cord Medicine* (2022) published a CPG titled Bone Health and Osteoporosis Management in Individuals with Spinal Cord Injury. Unfortunately, no BMD values for contraindicating weight-bearing activities have been established by research evidence to date, but the Bone Health CPG recommends using BMD values from dual-energy X-ray absorptiometry or peripheral quantitative computed tomography scans combined with clinical risk factors to assess facture risk prior to engaging in weight-bearing activities. They also advise that it is important for clinicians to take a proactive approach in order to help individuals with SCI to maintain bone mass and reduce the risk of future fracture-related morbidity and mortality. A summary of recommendations from the Consortium for Spinal Cord Medicine (2022) CPG is as follows.

Recommendations

3.5.1 We recommend that health care providers assess fracture risk at least annually (1B).

3.5.2 We recommend assessment of non-bone mineral density (BMD) risk factors for fracture following a change in functional abilities, minor injury after a fall, or a fragility fracture (1B).

3.5.3 We recommend assessment of lower extremity regional fracture risk with consideration for prior fracture history and BMD in the regions of the hip, distal femur, and proximal tibia (1B).

3.5.4 We recommend providing fall prevention education, transfer and wheelchair skills training, and/or balance training to individuals with SCI who have experienced a fall to reduce fall risk and increase confidence in community participation (1D).

Rationale

It is crucial to be aware that bone loss is a major sequela in individuals with SCI and results in a high risk for fragility fractures. Fragility fractures highly affect the health of individuals with SCI because they can contribute to high morbidity and mortality. The fracture thresholds and breakpoint values, risk factors for fragility fracture, and fracture risk fracture checklist of factors to consider prior to BMD testing are summarized in Tables 5, 6, and 7, respectively, below. Appropriate monitoring and regular assessment for osteopenia or osteoporosis is vital to individuals with SCI for this reason. Prevention of fragility fractures is key to management. *Please see the Consortium for Spinal Cord Medicine CPG (2022)* Bone Health and Osteoporosis Management in Individuals with Spinal Cord Injury *for further recommendations on medical*

Table 5. Fracture Threshold and Fracture Breakpoint Values in Individuals With SCI[a]

Name	Value[b]	Definition
Fracture threshold	≤ 0.78 g/cm^2 (aBMD) < 114 mg/cm^3 (vBMD-femur) < 72 mg/cm^3 (vBMD-tibia)	Knee region BMD values below which fragility fractures occur
Fracture breakpoint	< 0.49 g/cm^2 (aBMD)	Knee region BMD values at which the majority of fragility fractures occur

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Abbreviations: SCI, spinal cord injury; BMD, bone mineral density; aBMD, areal BMD; vBMD, volumetric BMD.

[a]Data derived from Eser et al., 2005, n=99, and Garland et al., 2005, n=10.

[b]BMD values below the fracture threshold infer increased (i.e., low-moderate) fracture risk and BMD values below the breakpoint infer high fracture risk (Garland et al., 2005).

Table 6 Risk Factors for Lower Extremity Fragility Fracture After SCI

Risk Factors
Age at injury < 16 years
Alcohol intake > 5 servings/day
Body mass index < 19
Duration of SCI ≥ 10 years
Woman
Motor complete (AIS A-B)
Paraplegia
Family history of fracture in men
Anticonvulsant use (i.e., Tegretol, Depakote, gabapentin – Neurontin)
Spasticity medication
Opioid analgesia use (≥28 mg morphine for 3 months)
Prior fragility fracture[a]
SSRI
PPI
Knee region BMD below the fracture threshold[a]

Adapted from the SCIRE Professional bone health chapter (Craven et al., 2020). Available at https://scireproject.com/evidence/rehabilitation-evidence/bone-health/fracture-risk-following-sci/

Abbreviations: SCI, spinal cord injury; AIS, American Spinal Injury Association (ASIA) Impairment Scale; SSRI, selective serotonin reuptake inhibitor; PPI, proton pump inhibitor; BMD, bone mineral density.

[a]The biggest 2 factors.

Table 7. Fracture Risk Factor Checklist Prior to BMD Testing

Established Fracture Risk Factors
□ Alcohol intake > 5 servings per day □ Paraplegia □ Duration of SCI ≥ 10 years □ Motor-complete injury (AIS A-B) □ Family history of fracture □ Hip fracture in the last year or prior lower extremity fracture
□ Routine use of benzodiazepines, anticonvulsants (i.e., carbamazepine, phenytoin), heparin, opioid analgesia (≥28 mg morphine for a 3-month period)

Abbreviations: BMD, bone mineral density; SCI, spinal cord injury; AIS, American Spinal Injury Association (ASIA) Impairment Scale.

treatment and interventions.

It is recommended that a patient's fracture risk be determined by completing the fracture risk factor checklist (Craven et al., 2008, 2009) as a triage tool. The presence of ≥ 3 risk factors implies a moderate fracture risk, and the presence of ≥ 5 risk factors implies a high fracture risk, both of these warrant BMD testing.

3.6 Health Management Behaviors and Adherence

Panel Findings

- Managing health after SCI is complex, requiring new skills, constant self-monitoring, and performance of SCI-specific tasks alongside attention to general health and life priorities.
- Greater injury severity increases the number of required health behaviors and the cognitive and interpersonal demands on individuals.
- Personal factors influencing self-management include social determinants (education, income, financial resources), psychosocial traits (self-efficacy, motivation, problem-solving), and cognitive functioning.
- Environmental factors such as social networks, assistive technology, and the built/attitudinal environment contribute health management outcomes.

Synopsis of Evidence

Management of health after SCI is complicated. For adults with SCI, independent management of their own physiological functioning often involves learning and maintaining many new and complex skills and behaviors, engaging in near-constant self-monitoring, and flexibly executing a range of tasks and behaviors specific to managing the SCI (e.g., self-catheterization, pressure redistribution; Krassioukov et al., 2010; Hicken et al., 2001; Benevento and Sipski, 2002) in addition to those associated with general health (e.g., healthy diet, physical activity) and other priorities (e.g., family, employment), each of which is often made more complicated because of the SCI-related impairment. As injury severity increases, so do the health behaviors that are required, as well as the cognitive and interpersonal demands placed on individuals living with SCI.

Personal, psychosocial, and environmental factors have been identified as having an effect on health management for individuals with SCI. Personal factors that relate to self-management involve social determinants of health (e.g., education, income, financial resources) and psychosocial characteristics (Munce et al., 2016, n=1,472), including self-efficacy, mastery motivation, activation, and problem-solving style (Dreer et al., 2004), as well as cognitive functioning (See Section 3.11). Environmental factors include social networks, assistive technology, and factors in the built and attitudinal environments (Pilusa et al., 2021; Reber et al., 2022).

Recommendations

3.6.1 We recommend providing self-management training to enhance health outcomes and associated self-efficacy and psychosocial factors (1D).

3.6.2 We recommend the use of multi-modal support strategies, including education, motivational interventions, peer mentoring, adapted activities, and digital health tools, to enhance therapy participation, mastery of self-care skills, self-efficacy, and long-term health outcomes (1C)

Rationale

Health and health management ultimately involves the behaviors of the individual given their physical and cognitive functioning and in the context of their priorities, culture, and environment. Health management may include *people* such as family members and health care providers; may interact with factors in *built environments* at home and in the community that support or serve as barriers to independence, as well as with *attitudinal environments* associated with culture, bias, and discrimination; and may rely on *resources and policies* such as insurance coverage and access to personal care attendants or assistive technology. When health is not able to be managed effectively, it results in increased rates of secondary conditions and comorbid conditions, decreased participation and employment, and higher costs for the individual, health care system, and society.

Individuals with SCI should be kept at the center of the health management process. Ethical guidelines and person-centered approaches, as well as practical considerations, enforce the importance of interacting with the person being treated and tailoring treatment to that person. Activities and explanations should be centered around their concerns, priorities, and goals, as well as their key activities and environments.

Health care providers should work in partnership with their patients with SCI and the care partners that they identify in order to enhance health outcomes and address the patient's long-term goals. Providers should be prepared to help the individual with SCI or dysfunction understand what is going on and what can be done to help address challenges and to negotiate an action plan to improve the likelihood of success. The use of theory driven and evidence based counseling techniques such as motivational interviewing may improve adherence to healthy behaviors such as physical activity guidelines and home exercise programs. (Hoekstra 2024, Vong 2011)

Many potential methods can enhance the management of health for individuals with SCI. These methods include education, hands-on skill development through rehabilitation therapies and therapeutic modalities and environments, and peer mentors to assist with expectations and model specific behaviors and attitudes. Adaptive and therapeutic sports and recreation is another potential way to enhance health management. Not only does it provide an opportunity for physical activity, but participation is also associated with increased self-efficacy and the development or restoration of a sense of self and identity (Rayes et al., 2022). Moreover, group activities provide an opportunity for social learning and the promotion of problem solving, communication, and teamwork.

Self-management—as a theoretically informed and evidence-based approach—has been shown to provide small to moderate improvements in behaviors, self-reported functioning, QOL, and health outcomes (Foster et al., 2007). Self-management techniques are typically most effective when they are longer (6+ weeks), include components of social support, provide access to information, promote self-monitoring, and provide feedback about behavior (Meade and Cronin, 2012). McIntyre et al. (2020) conducted a scoping review in which they identified and reviewed 112 studies representing 102 self-management programs for individuals with SCI; unfortunately, most of these programs were not assessed with sufficient rigor to make strong statements about their effectiveness. Another systematic review of 16 trials with experimental study designs concluded that 3 intervention components (education, psychological strategies, and social support) may increase leisure time physical activity in patients with SCI (Tomasone et al., 2018). Another systematic review on self-management of skin in adults with SCI suggested its possible effectiveness in SCI, although the investigators concluded that the preponderance of evidence is fairly limited (Baron et al., 2018, part 1). A systematic review focused on self-management for either pain or depression accompanying SCI; it concluded that efficacy was unclear and that existing interventions tended to focus on medical tasks to the exclusion of

those related to management of emotions and roles (Cadel et al., 2020).

Finally, mHealth and internet- or online-based (i.e., electronic health [eHealth]) interventions are worth reviewing to determine their ability to supplement usual care. A 2016 systematic review of telerehabilitation and mHealth interventions for SCI (Wellbeloved-Stone et al., 2016) identified 12 studies, only 2 of which focused on mHealth. More recent eHealth and mHealth interventions for individuals with SCI include Care Call (Mercier et al., 2015; Houlihan et al., 2013), Virtual Coaches (Shamekhi et al., 2016), and the iMHere (Interactive Mobile Health and Rehabilitation) 2.0 system (Kryger et al., 2019). The feasibility of each has been established with individuals with SCI and initial research appears to support their possible benefit in enhancing knowledge, health management behaviors, and health outcomes, as well as the associated psychological constructs of self-efficacy and activation. However, the sustainability and ongoing availability of these systems is unclear.

3.7 Comorbid Mental Health Conditions (e.g., Depression, Anxiety, Post-Traumatic Stress Disorder, Substance Use Disorders)

Panel Findings

- Individuals with SCI have higher rates of depression, anxiety, post-traumatic stress disorder (PTSD), and substance use disorders than do non-disabled individuals.
- The level and severity of injury, as well as demographic characteristics, are poor predictors of mental health conditions.
- The presence of 1 or more comorbid mental health conditions is related to a higher mortality rate, poorer health, and lower life satisfaction.

Synopsis of Evidence

Having a mental health disorder is related to worse health outcomes such as higher rates of mortality (Findley et al., 2011). In 280 veterans with SCI, those with mental health disorders reported lower life satisfaction and more impaired health (McDonald et al., 2018). A meta-analysis of 18 studies showed that having a comorbid mental health condition is associated with having greater pain and infections (Craig et al., 2009). Weak evidence from 2 studies suggested that a history of substance use may adversely influence functional improvement (Bombardier et al., 2004, n=76; Harper et al., 2022, n=1,376).

In large samples of veterans with SCI, 18%-40% have at least 1 comorbid mental health condition (Findley et al., 2011, n=8,334; Ullrich et al., 2014, n=41,213). The most recent meta-analysis shows that approximately 22% have a major depressive disorder (Williams and Murray, 2015), 10% have anxiety disorders, 11% have suicidal ideation (Khong et al., 2023) and 6% have PTSD (Findley et al., 2011). The prevalence of diagnosed substance use disorders is 3.7% for alcohol, 1.4% for cannabis, 1.7% for opioids, and 27.3% for nicotine based on 1.4 million cases treated in a large university health care system (Graupensperger et al., 2019). The odds of being diagnosed with a substance use disorder are 4.19-7.97 times higher in individuals with SCI than in individuals without SCI.

Having a mental health condition is generally unrelated to demographic and clinical variables such as sex, age, marital status, and race; the level and severity of injury; or the time since injury (Ullrich et al., 2014). However, being single or living alone are correlated with having mental health diagnoses (Noonan et al., 2014; Carrard et al., 2021).

Recommendations

3.7.1 We recommend that health care providers screen individuals with SCI for mental health and substance use-related problems at regular intervals and those with positive screens should undergo more detailed assessment. 1D

3.7.2 We recommend that health care providers should treat individuals with SCI for comorbid mental health or substance use disorders to improve health outcomes and reduce mortality. 1D

Rationale

The Consortium for Spinal Cord Medicine CPG on managing mental health, substance use, and suicide recommends screening for these conditions on the basis of their high prevalence, the inherent suffering caused, and the negative effects on health and functioning (Bombardier et al., 2021). There is evidence that, for example, depression is undertreated in individuals with SCI, that screening measures are reliable and valid (Bombardier et al., 2021), and that universal screening may boost receipt of treatment and overall mental health (Fann et al., 2011). Mental health conditions can be chronic, episodic, or recurrent, justifying the need for repeated screening over time (Bombardier et al., 2021). Individuals whose screening results are positive should undergo follow-up diagnostic interviews because screening tools may have relatively weak diagnostic specificity (Bombardier et al., 2021). Although SCI-specific research is limited, robust evidence indicates that pharmacological and nonpharmacological treatments for mental health and substance use disorders are effective in nondisabled populations (Bombardier et al., 2021).

3.8 BMI and Body Habitus

Panel Findings

- Individuals with SCI who are overweight are more likely to experience a greater impact of overuse injuries and fatigue, have greater pain and depressive symptoms, and have lower satisfaction with life than those who are not overweight.
- Community mobility is lower in underweight, overweight, and obese groups than in those with normal weight.
- The literature suggests a positive correlation between cardiometabolic syndrome and PIs in individuals with SCI.
- Adult men and women with SCI who have a BMI ≥ 22 kg/m2 are at high risk for cardiometabolic disease.

Synopsis of Evidence

A study by Hatchett et al. (2016, n=222) showed that individuals with SCI with higher BMIs pushed their wheelchairs shorter distances, although other mobility measures such as velocity, number of daily transfers, and depression raises (i.e., push-up or vertical lift) were not affected by body weight. Individuals with paraplegia who are obese have lower FIM self-care and mobility score gains at discharge than do their normal-weight peers. In individuals with tetraplegia who are obese, FIM self-care and mobility ratings are not significantly different from ratings for their normal-weight peers (Stenson et al., 2011, n=1,524).

For each additional 3 units above the average BMI of 25, one large-scale study observed a decrease of 1 point in transfer ability on the admission estimate for the FIM transfer subscore. This may reflect the upper body function required to move one's body mass with little or no contribution from the lower extremities (Kozlowski and Heinemann, 2013, n=1,146). Individuals who reported being overweight were more likely to have a history of overuse injuries and fatigue and to experience a greater impact of overuse injuries and fatigue (Hetz et al., 2011). For individuals with tetraplegia and functional motor-complete injuries, rehospitalization occurred more frequently among obese persons, whereas days rehospitalized were the longest among underweight persons (Chen et al., 2011).

The literature suggests a positive correlation between cardiometabolic syndrome and PIs in individuals with SCI (Li et al., 2016), people with SCI who are underweight are also at greater risk for PIs (Wang et al., 2025).

Recommendations

3.8.1 We recommend providing education for and monitoring of PIs in individuals with SCI who are overweight or underweight because of their increased risk (1C).

3.8.2 We recommend that a body mass index (BMI) of ≥ 22 kg/m2 be used as the cutoff point for obesity when BMI is used as a surrogate marker for obesity in individuals with SCI (1B).

Rationale

Individuals with SCI who are overweight are more likely to experience a greater impact of overuse injuries and fatigue, have greater pain and depressive symptoms, increased risk for PIs and lower satisfaction with life than individuals with SCI who did not report being overweight.

3.9 Physical Inactivity, Deconditioning, and Sedentariness

Panel Findings

- A large fraction of individuals with SCI are physically inactive.
- In individuals with SCI, moderate to vigorous physical activity is positively correlated with walking function, muscular strength, upper extremity function, wheelchair propulsion, and indicators of cardiometabolic health.
- Moderate to vigorous physical activity is inversely

correlated with spasticity, pain, anxiety, and depression in SCI.

Synopsis of Evidence
Individuals with SCI engage in low levels of leisure time physical activity ranging from 27 to 51 minutes per day, and 18%-50% are considered inactive (Martin Ginis et al., 2010; Jorgensen et al., 2017b; Rauch et al., 2017). Fifty percent of 695 individuals with SCI reported engaging in no leisure-time physical activity (Martin Ginis et al., 2010).

Results of a meta-analysis suggested moderate-certainty evidence that physical activity aids in improved walking function, muscular strength, and upper extremity function (Carty et al., 2021). Low-quality evidence indicates that physical activity may reduce shoulder pain and improve vascular function in paralyzed limbs (Carty et al., 2021). Low-quality evidence also suggests that physical activity may enhance health-related QOL (Carty et al., 2021). Engaging in guideline-consistent aerobic conditioning and strength training may improve indicators of cardiovascular health such as lipid profiles, inflammatory markers, and fat mass (Martin Ginis et al., 2018). Greater moderate and strenuous physical activity (but not mild activity) may decrease depression and anxiety (Battalio et al., 2020).

Recommendations
3.9.1 We recommend screening for physical inactivity and use of evidence-based interventions to help individuals with SCI meet physical activity guidelines when possible (1D).

Rationale
SCI-specific physical activity guidelines are available (Martin Ginis et al., 2018). Guideline-consistent physical activity appears to be beneficial to a wide range of individuals with SCI in terms of age, injury level, and severity (Martin Ginis et al., 2018). Clinic and community-based physical activity programs can be effective (Ma et al., 2019, Chiou et al., 2022).

As is true for the general population, individuals with SCI are cncouraged to engage in moderate to vigorous physical activity on a regular basis. For adults with spinal cord injury who are beginning an exercise program, it is recommended to gradually progress toward completing at least 20 minutes of moderate-to-vigorous aerobic activity twice per week, along with three sets of strengthening exercises for each major muscle group (including the chest, shoulders, back, arms, core, and legs) performed twice weekly. Once comfortable with maintaining 20 minutes of moderate-to-vigorous aerobic exercise twice weekly, progress to an advanced level, which includes 30 minutes of moderate-to-vigorous aerobic exercise 3 times per week while continuing 3 sets of strengthening exercises for each major muscle group twice weekly, to obtain additional health and fitness benefits (Martin Ginis et al., 2025). Moderate-intensity activity is characterized by a level of effort that feels somewhat difficult. During this level of exertion, talking is possible, but singing is not. Vigorous-intensity activity is characterized by a level of effort that feels very challenging. At this intensity, the activity can be sustained only for short periods, and speaking more than a few words without pausing for breath is not possible (SCI Guideline Development Group).

3.10 Age

Panel Findings
- Age at the time of injury and number of years after injury both influence outcomes after SCI.
- Age at injury, time since injury, or both have been associated with an increased incidence of secondary health conditions after SCI.
- Older age at the time of injury predicts a higher mortality rate within the first year after SCI.
- Older age is associated with decreased functional and psychosocial outcomes in SCI.
- Individuals with SCI can improve QOL independent of age at time of injury, and QOL remains favorable as individuals age with SCI.

Synopsis of the Evidence
Age at the time of injury can provide information related to outcomes after SCI. Individuals with SCI who were older than 65 years had higher mortality rates than those who were younger than 65 (38.6% vs. 3.1%, respectively) at 6 weeks, 6 months, and 1 year after injury in a sample of almost 500 (Furlan and Fehlings, 2009). In another study that investigated over 3,000 participants, the authors found that those aged 70 years or older had a higher mortality rate during hospitalization and at 1-year follow-up than did younger participants; mortality rates correlated with the severity of neurological injury (Fassett et al., 2007). A systematic review that included clinical prediction of

survival among other outcomes after SCI included 51 studies, of which 15 reported on survival (Wilson et al., 2012a). The authors summarize results across multiple studies and conclude that increasing age is a positive predictor of mortality rate, although not all studies adjusted for confounding variables such as injury severity and level of injury (Wilson et al., 2012a).

A systematic review of 21 studies concluded that older individuals with SCI can improve their QOL with rehabilitation (Sakakibara et al., 2012). Krause et al. (2015) completed a series of longitudinal studies with a sample of over 2,000 participants with SCI across 40 years and summarized their results from multiple publications. These data suggest that individuals who were older at the time of their injury had decreased reports of subjective well-being, a measure designed to capture a variety of constructs (Krause et al., 2015). Another study of nearly 2,000 participants from the same longitudinal sample reports that the older someone was at the time of injury, the lower their initial scores of emotional distress, environmental barriers, money, and lack of opportunities (Li et al., 2021).

For information related to age at time of injury and the relationship to walking outcomes and neurological outcomes, please refer to Section 1 (Neurological Outcomes) and Section 2.7 (Walking) in this CPG. Age is also associated with functional outcomes; a systematic review that include 51 studies summarized the literature and concluded that older age is associated with decreased functional outcomes (Wilson et al., 2012a). Specifically, using the FIM as the primary outcome, Furlan and Fehlings (2009) studied nearly 400 participants with SCI and found that although there was a relationship between younger age at onset of injury and improved function in both the acute and chronic time period after SCI, there was no relationship with functional recovery, defined as the difference in FIM scores between 6 weeks and 1 year after SCI. The authors also reported that the neurological improvement seen in older individuals with SCI does not result in an equivalent amount of functional improvement, as seen in the younger SCI population (Furlan and Fehlings, 2009).

Time since injury and aging with an SCI can also provide information related to outcomes after SCI. In a longitudinal study by Krause et al. (2015), the authors report on the survivor effect, which explains that individuals who are more active and employed had improved psychosocial adjustment and were more likely to live to future study follow-ups. They also report that participation in social activities and sitting tolerance were both associated with improved mortality. The authors concluded that aging and time since injury had the largest impact on social and medical outcomes, whereas employment outcomes did not change. Economic satisfaction improved over time, and general satisfaction as defined by social life, sex life, and health decreased (Krause et al., 2015).

In a study that used the same longitudinal sample of over 2,000 participants, the authors investigated how self-reported problems (health, social isolation, emotional distress, environmental barriers, money, and lack of opportunities) change over the span of 25 years in individuals with SCI (Li et al., 2021). This study concluded that years after injury at the time of the initial assessment resulted in lower scores for social isolation, emotional distress, environmental barriers, and lack of opportunities. However, over time, problems of social isolation, emotional distress, environmental barriers, money, and lack of opportunities decreased, whereas health problems increased (Li et al., 2021). In a systematic review by Sakakibara et al. (2012), they conclude that independent of age, individuals with SCI can improve their QOL and maintain good or excellent QOL after 16 years after injury. However, the authors report that the studies were considered to have low levels of evidence and recommend longitudinal studies with improved methodology to confirm the findings (Sakakibara et al., 2012).

Additional factors can be considered as individuals age with an SCI. A large database study showed that with increased time after SCI, institutional residence decreased, life satisfaction increased, and no trends were found related to UTIs, diabetes, self-perceived health, pain, or alcohol use disorder. However, older individuals with SCI did show increased prevalence of institutional residency, pressure injuries, and diabetes, as well as decreased self-perceived health. Nevertheless, long-term survivors of traumatic SCI generally maintained relatively strong independence and social participation (Chen et al., 2022; n=20437). A scoping review with 92 studies concluded that some secondary health conditions occur more in individuals who are older or when there has been a longer time since injury. The authors acknowledge the difficulty of interpreting the literature in this area, as well as the paucity of longitudinal studies; however, their review concludes that the health conditions that have been found to be consistently associated with age and/or time since injury include cardiovascular disease, loss of BMD, fatigue, and respiratory issues (Jensen et al., 2013). In a sample of 7,019 individuals with traumatic SCI compared with individuals without SCI, the authors concluded that individuals with SCI are at an increased risk for Alzheimer disease and related dementia (Mahmoudi et al., 2021).

Recommendations

3.10.1 We recommend considering age at injury onset, as well as aging with an SCI, when determining outcomes for individuals with SCI (1C).

Rationale

Multiple studies have investigated the effect of age at the time of injury and time since injury on outcomes such as mortality, function, QOL, and other participation outcomes (Fassett et al., 2007; Furlan and Fehlings, 2009; Krause et al., 2015; Li et al., 2021; Sakakibara et al., 2012; Wilson et al., 2012a), as well as the incidence of secondary health conditions (Jensen et al., 2013; Chen et al., 2022). Older age and aging with an SCI influence outcomes and therefore it is important that support be provided to individuals with SCI throughout their lives as they age with an SCI to maximize outcomes across a variety of domains. Despite some of the negative outcomes and barriers associated with aging with an SCI, individuals have the potential to have a high QOL when living with an SCI (Sakakibara et al., 2012).

3.11 Cognition (Cognitive Impairment, Neurocognitive Influences)

Panel Findings

- Individuals with SCI have an elevated risk of comorbid cognitive impairment.
- Multiple common comorbid conditions can potentially cause cognitive impairment.
- Severe TBI causes cognitive and other functional impairments; however, the extent to which less severe TBI or other comorbid conditions cause functional impairments is uncertain.

Synopsis of Evidence

A systematic review of studies related to cognitive function after SCI concluded that individuals with SCI are at elevated risk of having significant cognitive impairment, whether they are compared with normative cutoffs (38 of 70 studies) or with nondisabled controls (15 of 21 studies; Sachdeva et al., 2018). Comorbid TBI is a main cause of cognitive impairment in SCI. From a review of 70 studies, TBI is estimated to occur in 16%-59% of individuals who sustain SCI (Sachdeva et al., 2018), although most TBIs that are coincident with SCI are mild (Macciocchi et al., 2008; Hagen et al., 2010; Bombardier et al., 2016). Three studies showed that age > 60 years was also associated with significant cognitive decline on the basis of testing and functional assessments in individuals with SCI (Sachdeva et al., 2018). Scattered evidence indicates that mild to moderate TBI, pain, fatigue, psychological disorders, decentralized cardiovascular control, and sleep apnea cause cognitive impairment significant enough to influence functional outcomes (Sachdeva et al., 2018; Macciocchi et al., 2012).

Recommendations

3.11.1 We recommend screening for cognitive and executive dysfunction throughout the life span and provision of appropriate evidence-based treatment (1D).

3.11.2 We suggest that clinicians recognize risk factors for cognitive impairment in individuals with SCI, including age >60 years, depression, anxiety, pain, fatigue, medication side effects, decentralized cardiovascular control (including orthostatic hypotension and autonomic dysregulation), and neuromuscular respiratory disorder (including hypoventilation, sleep-disordered breathing, and sleep apnea) (2D).

Rationale

Individuals with SCI merit cognitive screening because cognitive impairment is prevalent and can adversely affect functional outcomes (Sachdeva et al., 2018). Many different comorbid conditions can cause cognitive impairment, and the presence of contributory conditions such as TBI are often overlooked (Sharma et al., 2014). In addition to TBI, psychological and other physical comorbidities are common in SCI and can adversely affect cognition (Sachdeva et al., 2018). Three of 6 studies of psychological comorbidities found

an association with worse subjective or objective cognition, and 3 of 4 studies of pain or fatigue found a correlation with worse cognition.

There is mixed evidence that decentralized cardiovascular control (e.g., hypotension or decreased cerebral blood flow), as well as obstructive sleep apnea that occurs frequently in SCI, may adversely affect cognition (Sachdeva et al., 2018). Age, typically older than 60 years, was associated with worse cognitive functioning relative to that in younger persons (<40 years old) in 3 of 5 studies. A weakness in the science is that most studies did not control for coexisting TBI (Sachdeva et al., 2018). Evidence-based cognitive assessment and rehabilitation strategies are available to mitigate the effects of TBI-related cognitive impairment (Ponsford et al., 2014; Tate et al., 2014).

3.12 Orthopedic Polytrauma and Upper Limb Pain

Panel Findings

- Acute-phase SCI rehabilitation can be significantly affected by the presence of concomitant orthopedic polytrauma.
- The high prevalence of upper limb pain and injury in SCI is well documented, as are the negative consequences on QOL.
- Shoulder pain is the most common clinically significant upper extremity problem in chronic SCI. Better transfer technique correlates with less injury and less pain.

Synopsis of Evidence

Upper body injuries, including upper limb fractures, rotator cuff injuries, complex scapular fractures, and sternal fractures or sternotomies that affect full weight-bearing and axial loading through the upper limbs may negate the ability for the newly injured to begin full physical rehabilitation. Achievement of level-of-injury functional goals may need to be delayed or modified until orthopedic restrictions are lifted. This can affect acute-phase care transitions and length-of-stay decision making.

Additional help with functional activities is often required as a result of upper limb pain or range-of-motion limitations. Activities with the highest intensity of reported shoulder pain are pushing up ramps or inclines, loading the wheelchair into the car, car transfers, and lifting objects down from an overhead or above-shoulder-level shelf. A large percentage of individuals with chronic SCI also report that dressing and grooming tasks cause significant pain, resulting in decreased participation, independence, and enjoyment of these activities, as well as of leisure and social activities.

Recommendations

To reiterate and remain in harmony with the Consortium for Spinal Cord Injury CPG titled Preservation of Upper Limb Function Following Spinal Cord Injury (Boninger et al., 2005):

3.12.1 We recommend monitoring for upper extremity repetitive use injuries and pain, particularly among users of manual wheelchairs and users of upper extremity assistive devices for ambulation (1C).

3.12.2 We suggest education and training for those at risk for upper extremity pathology due to repetitive use, including discussion of the pros and cons of using power assist or powered mobility (2C).

Rationale

To remain in harmony with the Consortium for Spinal Cord Medicine CPG titled Preservation of Upper Limb Function Following Spinal Cord Injury (Boninger et al., 2005):

For individuals with SCI, paralysis of the lower limbs necessitates reliance on the upper limbs for mobility. This greater reliance on the arms can lead to pain and injury, which can have an impact not only on mobility, but also on the ability to complete activities of daily living.

Overuse of the upper limbs commonly results in the diagnosis of rotator cuff tears, osteoarthritis, or impingement syndrome. An increase in body weight is associated with an increased risk of developing musculoskeletal and overuse injuries. Pain resulting from overuse injury leads to limitations in daily tasks and mobility.

3.13 Use of Adaptive Technology

Panel Findings

- Adaptive technology, including environmental controls, positively influences functional outcomes after SCI.
- Assistive computer technology has a positive impact on multiple factors such as QOL, perceptions of competency, self-esteem, and independence for individuals with SCI:
  - Daily internet use is associated with lower depression.
- Individuals with SCI rely on computer and internet use to access resources for health information or education, communication, future employment, and improved self-care:
  - Computer technology improves functional outcomes by promoting competence, autonomy, and inclusion.
  - Assistive technology is critical for making computer systems more accessible to individuals with SCI, including adaptive devices, onscreen keyboards or touch screens, and voice recognition systems.
- Despite increased internet usage, barriers persist, include age, level of injury, education level, race, and time since injury.
- Being a White person, younger, and healthier is associated with greater computer use among veterans.
- Environmental control systems are associated with higher ratings of independence in activities and satisfaction with them.
- Smart home technologies have the potential to affect environmental controls in the home of individuals with SCI.
- Improved control of the home environment may increase QOL and satisfaction.

Synopsis of Evidence

Relationships Among Adaptive Technologies and Functional Outcomes. Advances in computer and internet technology can be beneficial to individuals with SCI as a reliable resource for health information or education, communication, future employment, and improved self-care (Goodman et al., 2008; Rigot et al., 2021; Cooper and Cooper 2010; Hogan et al., 2016; McKinley et al., 2004). Internet usage among individuals with SCI increased from 77.7% to 88.1% from 2012 to 2018 (Rigot et al., 2021). Studies have shown that daily internet use is associated with a reduced probability of depression (Tsai et al., 2014b) and that the use of computer technology promotes competence, autonomy, and inclusion (Monden et al., 2019). Despite benefits of internet use, not all individuals with SCI are online. Barriers to internet usage may include older age, lower education levels, non-White race, lower income, level of injury, and time since injury, although the authors say that these disparities have decreased over the past decade (Rigot et al., 2021, n=13,622; Goodman et al., 2008, n= 2,926).

Studies show that individuals with SCI most often access their computers and devices by using trackballs, typing aids, adapted keyboards, touch screens, and voice-recognition software, the latter used primarily by individuals with tetraplegia (Hogan et al., 2016; Post et al., 2019; Cooper and Cooper, 2010). The literature on the impact of environmental control systems on the functional outcomes of individuals with SCI is limited and features small sample sizes.

Impact of Environmental Control Systems and Smart Home Technology. Higher independence ratings are reported by individuals who use environmental control systems (Croser et al., 2001; n=8), as well as greater satisfaction in areas of meal preparation, sleep, excretory hygiene, health care, and household management (Vincent et al., 2002; n=5). However, the sample size of these studies is too small to generalize. A systematic review of 11 studies that examined the QOL, activity, participation, and user satisfaction outcomes of environmental control systems and smart home technology concluded that the small sample sizes and variability in study design made it difficult to draw conclusions (Brandt et al., 2011). In addition, the studies are several years old and smart home technologies are now more advanced and more widely available to users of all abilities. More evidence is needed on the impact of smart home technologies and environmental controls in the homes of individuals with SCI.

Recommendations

3.13.1 We recommend exposing people with SCI to evidence-informed internet resources that expand knowledge about health information, employment, communication, and improved self-care (1D).

3.13.2 We recommend exposing people with SCI to assistive technology in acute care and inpatient rehabilitation to have the most salient impact on functional outcomes (1D).

3.13.3 We recommend adaptations and specialized assistive technology that is congruent with functional abilities (1D).

3.13.4 We recommend addressing AT needs in people who have been shown to experience barriers to computer and assistive technology (non-White, older age, greater injury severity, lower educational levels, greater time since injury) (1D).

3.13.5 We recommend providing information about federal, state, and local resources for assistance with funding assistive technology (1C).

Rationale

The internet, computers, and assistive technologies are tools for improving functional outcomes after SCI. Studies show that assistive technology has positive effects on accessing information, independence, and controlling the environment (Goodman et al., 2008; Rigot et al., 2021; Cooper and Cooper 2010; Hogan et al., 2016; McKinley et al., 2004), as well as on psychosocial factors such as QOL, perceptions of competency, and self-esteem (Tsai et al., 2014b; Monden et al., 2019). Despite limited research on the utility of environmental control systems, such systems are instrumental in increasing independence and control over one's environment and should be introduced to individuals with SCI (Vincent et al., 2002). Individuals with SCI and their support persons should be provided with information about assistive technologies early after injury and frequently throughout the continuum of care, as functional abilities may change and new technologies may be introduced.

Smart home technology is rapidly changing and becoming more accessible to users of all ability levels. Barriers to access should be addressed with individuals with SCI as soon as possible in their acute and rehabilitation hospital stays by introducing various options for technologies and their use for home, work, and community use. Therapists or assistive technology professionals have advanced knowledge and skills in working with assistive technology and can help individuals with SCI tailor smart home technology options for their individual needs.

3.14 Socioeconomic Status

Panel Findings

- Individuals with SCI with a higher SES, including higher levels of education, typically experience higher levels of QOL.
- Public insurance, in particular having Medicaid as a payor source, is associated with more negative outcomes for adults with SCI than having private or commercial insurance.
- Limited access to financial and social resources, including private health insurance, education, income, and residence in safe neighborhoods, can negatively affect access to inpatient rehabilitation and outpatient health care, as well as health, community participation, and employment outcomes for individuals with SCI.
- Higher education, in particular having a college education, is associated with better health, functioning, participation, and QOL outcomes for adults with SCI.

Synopsis of Evidence

Relationship Between SES and Outcomes. Individuals with a lower SES may have reduced health, functioning, and QOL following SCI due to fewer resources and inaccessibility to health care (Jorge et al., 2018, n=26 studies; Dru et al., 2019, n= 21,985; Pacheco Barzallo et al., 2021, n=12,092). Research consistently shows that that low income predicts shorter life expectancies after SCI (Jorge et al., 2018, n=26 studies; Krause et al., 2012, n=7,955; Krause and Saunders, 2011, n=8,027; Strauss et al., 2008, n=7,331; Krause and Broderick, 2004, n= 5,947), with 1 large cohort study reporting that individuals with SCI with incomes of <$25,000 have 2.31 times the odds of mortality compared with an individual with SCI with a high income (95% CI 1.76-3.02; Krause and Saunders, 2011, n=8,027).

Along with higher mortality rates, low income may be associated with reduced mental health (Fekete et al., 2014, n=1,549), including a higher incidence of anxiety and depression (Lim et al., 2017, n=3,556). Other large studies identify income as a significant predictor of pain intensity, PIs, participation, and QOL (Fekete et al., 2014, n=1,549; Saunders et al., 2012, n=2,549).

In 1 study, those with an income of <$25,000 had higher odds of having a current pressure ulcer than did someone with an income of $75,000 or greater (odds ratio [OR] 2.03, 95% CI 1.42-2.91). In another study, financial hardship was consistently related to reduced health in secondary conditions, comorbidities, pain intensity, participation, and QOL (Fekete et al., 2014, n=1,549). In contrast, the absence of financial hardship, having paid work, and reporting higher subjective status were associated with higher belongingness, greater relationship satisfaction, and fewer problems with social interactions (Fekete et al., 2021, n=12,330).

Relationship Between Education and Outcomes. The literature indicates that higher education is associated with better outcomes in individuals with SCI (Fekete et al., 2014, n=1,549; Whiteneck et al., 2012, n=1,032; Krause and Saunders, 2011, n=8,027). A cross-sectional study by Fekete et al. (2021, n=1,549) examined socioeconomic disparities in health indicators and found that individuals with SCI who had higher levels of education had better mental health (p=0.039) and QOL than did individuals with SCI who had lower levels of education(p=0.002). Similarly, Whiteneck et al. (2012, n=1,032) found that individuals with SCI who were college-educated prior to injury had higher chances of being employed or in school at 1-year after injury (OR 3.173, p<0.001) than did those with a high school education only (OR 1.283, p= 0.372). In addition, physical independence (p<0.001), social integration (p=0.006), occupation (p=0.000), and mobility (p<0.001) CHART scores were higher for individuals with a college education. Another large cohort study evaluating the association between formal education and the risk of mortality after SCI showed that having a bachelor's degree or higher had 0.56 times the odds of mortality compared with someone with less than a high school degree, and that those with a high school or an associate degree had 0.81 times the odds of mortality compared with someone with less than a high school degree (Krause et al., 2011, n=8,027).

Association Between Access to Care, Including Payer Source and Availability of Providers and Outcomes. Multiple factors contribute to unmet health care needs, including transportation, inadequate provider, lack of information, and unavailable service. However, health care cost is often the most common barrier to health care access, even for upper-income groups (Pacheco Barzallo et al., 2021, n=12,092). A cross-sectional study by Saunders et al. (2012) investigated the effects of SES and health care accessibility on pressure ulcer outcomes after SCI (n=2,549). Individuals who could not afford to see a doctor were more likely to have a current pressure ulcer and had more reduced sitting time due to a pressure ulcer in the past year; individuals with SCI who did not have a primary care physician had lower odds of receiving surgical management of their PIs. Evidence suggests lower SES and income are associated with lower odds of surgical intervention (Dru et al., 2019, n=21,985).

Research suggests that adults with SCI who have public insurance such as Medicare, Medicaid, and Workers' Compensation experience poorer outcomes than do individuals who have private insurance (Whiteneck et al., 2012, n=1,032). As part of the SCIRehab study, Whiteneck et al. (2012, n=1,032) found that individuals with Workers' Compensation had a lower likelihood of being in work or school at their 1-year injury anniversary (OR 0.365, p=0.006) and lower CHART physical independence scores (p=0.002). Medicaid as a primary payer was also associated with lower chances of being in work or school at the 1-year injury anniversary, lower social integration and mobility (p=0.001) CHART scores, and a higher likelihood of rehospitalization before 1 year after injury (Whiteneck et al., 2012, n=1,032). More recently, Peterson et al. (2022, n=16,500) examined insurance claims of adults with SCI with either Medicare or private health insurance. Prevalence and incidence estimates of common psychological, cardiometabolic, and musculoskeletal morbidities were compared at baseline and at 4 years after index diagnosis, and survival models were used to quantify hazard ratios for outcomes, controlling for insurance type, sociodemographic characteristics, and other comorbidities. Results showed that adults with traumatic SCI who had Medicare had a significantly higher prevalence and risk for developing common chronic health conditions, including those associated with cardiometabolic, musculoskeletal, and psychological health, than did privately insured adults with traumatic SCIs.

Conversely, a cohort study by Krause and Broderick

(2004) found that there were no significant differences in mortality rates between individuals with private insurance, Medicaid, Medicare, or health maintenance organization third-party sponsorships (n=5,947). For those 65 years and younger, Workers' Compensation insurance lowered the odds of dying each year by 57%. For persons 65 years and older, having Workers' Compensation also lowered the odds of dying by 2%, but these results were no longer significant. A follow-up study by Strauss et al. (2008) reassessed the previous findings with an expanded participant database and found that Workers' Compensation had a much smaller beneficial effect on life expectancy that was no longer significant (Strauss et al., 2008, n=7,331).

Recommendation

3.14.1 We recommend that a case manager or social worker be included in the SCI health care team in both inpatient and outpatient settings to facilitate access to resources (1D).

Rationale

Disparities associated with SES and social determinants of health reflect both individual biases on the provider level, as well as systemic factors associated with how health care providers are trained and how health care is structured and provided. It is recommended that health care partners with their clinical teams, patients, and communities fix ineffective models of care provision and advocate for programming, policy changes, and more comprehensive supports for individuals with SCI and other disabilities.

The quality of the patient-provider relationship has also been found to have a significant effect on health outcomes for individuals with SCI (Meade et al., 2011). This relationship does not exist in a vacuum, SES can shape both the experience of the individual with SCI, and the provider's ability to deliver effective, patient-centered care. Individuals with lower SES may face barriers such as limited access to specialized care, reduced time with providers, or communication challenges rooted in differences in health literacy or cultural background (Jorge et al, 2018). These challenges can make it harder to build rapport, limit trust, and reduce the effectiveness of care interactions. Practical steps that providers can take to enhance their relationships include exhibiting nonverbal attentiveness, eliciting underlying fears, addressing immediate concerns, providing reassuring messages, engaging in interactive conversation, tailoring the regimen, planning for decision making, setting short-term treatment goals, making a long-term treatment plan, showing nonverbal encouragement, and giving verbal praise (Meade et al., 2011; Cabana et al., 2006; Clark et al., 1998).

3.15 Influence of Standard Rehabilitation

Panel Findings

- Individuals with more severe injury and medical complications have longer lengths of stay.
- Specific skills that appear to benefit from longer lengths of stay include bowel management, bed mobility, manual wheelchair skills, and using the stairs.
- Associations have been observed between lengths of stay and age, race, marital status, and employment status.
- Dose of therapy is a complex construct to capture.
- Evidence from large studies suggests that there are measurable benefits to higher doses of rehabilitation therapies.
- Specialized multidisciplinary rehabilitation is associated with greater functional outcomes.
- More active participation in inpatient rehabilitation therapies predicts superior short-term and long-term functional outcomes.

Synopsis of Evidence

In the United States, the change in lengths of stay for acute rehabilitation following SCI has declined dramatically in the past 50 years. The average length in the 1970s was 98 days, declining by more than two-thirds to 30 days in 2025 (National Spinal Cord Injury Statistical Center, 2025). As may be expected, longer lengths of stay are usually related to greater injury severity (Eastwood et al., 1999; Craven et al., 2017). A study of almost 4,000 participants confirmed that individuals with incomplete paraplegia have shorter lengths of stay than do individuals with complete tetraplegia, incomplete tetraplegia, or complete paraplegia (Eastwood et al., 1999). Further, individuals who are able to urinate with no device or assistance have shorter lengths of stay than do those who require any type of bladder management (e.g., indwelling catheter, intermittent catheterization, condom; Eastwood et al., 1999).

A study of outcomes at discharge from acute SCI rehabilitation (including over 3,000 participants) found that across most SCI neurological classifications, longer lengths of stay are associated with greater functional independence at discharge (Kao et al., 2022). There are methodological flaws with a systematic review that concluded that rehabilitation length of stay was not a significant predictor of functional recovery (Richard-Denis et al., 2018). Specifically, of the 5 studies cited in this review, 3 were reports from the same data set of the SCIRehab project (with 1,376 participants). The overall conclusions of the SCIRehab project was that patient characteristics are the primary driver of length of stay and of functional outcomes (Whiteneck et al., 2012). However, 2 of the SCIRehab discipline-specific articles reporting on physical therapy (Teeter et al., 2012) and occupational therapy services (Ozelie et al., 2012) found that there was an association between the amount of these services and motor outcomes when homogeneous subgroups were analyzed. The other 2 of the 5 studies included in the systematic review were reports on outcomes in Saudi Arabia, where the time between injury and admission to rehabilitation is an average of 377 days (Mahmoud et al., 2017).

A study of almost 4,000 participants found that those more likely to have shorter lengths of stay include individuals who are younger than 21 years of age, married, retired, or African American (Eastwood et al., 1999). Some aspects of shorter lengths of stay may be desirable, in particular from the financial perspective for which shorter lengths of stay are associated with savings of $20,000 to $50,000 in care costs per patient (Truchon et al., 2017).

The dose of rehabilitation therapy is a multifactorial variable that can be difficult to characterize. Dose includes number of repetitions, duration of sessions, number of sessions, physiological intensity of training, and extent of participation (i.e., motivation) of the patient or client. In the rehabilitation literature, dose is most commonly defined as the amount of time spent in therapies. Two larger studies that have each included over 1,000 cases suggest that there are measurable benefits to higher doses of rehabilitation therapies (Teeter et al., 2012; Canori et al., 2020).

Because of the high variability in functional abilities in individuals with motor-incomplete SCI, the best evidence related to the impact of therapy dose on outcomes can be found in studies of homogeneous groups of individuals with motor-complete SCI. Although it may be necessary for individuals with motor-complete injuries to learn compensatory movement strategies, there is potential for training-related improvement in motor function within the ZPP. For individuals with motor-incomplete SCI, a large body of evidence shows that practice and training improve volitional control of movement. Much of this literature is described in Section 2.7 on Walking and Section 2.8 on Arm and Hand Function.

Although higher doses of therapy are assumed to be associated with longer lengths of stay, the structure of that stay is also likely to influence outcomes. In individuals with tetraplegia, longer length of stay and more time spent on building skills in clothing management and toileting-related hygiene is associated with higher motor function scores at discharge (Ozelie et al., 2012). Rehabilitation involving a program of specialized multidisciplinary treatment is associated with greater functional outcomes (Richard-Denis et al., 2018). It is possible that the expertise of providers in a specialized program of SCI care allows them to better structure the dose and content of therapy to the specific needs of the individual.

Therapist ratings of how actively patients participated in physical therapy and occupational therapy during inpatient SCI rehabilitation significantly predicted functional outcomes at discharge and at 1 year after injury in a large multisite cohort study (Ozelie et al., 2012; Teeter et al., 2012). Higher therapy participation ratings by the physical therapist on a standardized scale intended to rate the level of participation predicted significantly higher motor FIM scores at rehabilitation discharge and at 1 year (Teeter et al., 2012). Higher participation in physical therapy also predicted a greater likelihood of discharge to home and return to work or school at 1 year, as well as higher scores on the CHART physical independence, social integration, mobility, and occupation scores at 1 year. Higher participation scores in occupational therapy predicted higher motor FIM scores at discharge and at 1 year, as well as a greater likelihood of return to work or school at 1 year (Ozelie et al., 2012). Greater occupational therapy participation also predicted higher CHART social integration, occupation, and mobility at 1 year.

Recommendations

3.15.1 We recommend that individuals with SCI receive specialized SCI care, including a multidisciplinary rehabilitation program (1A).

3.15.2 We suggest that inpatient rehabilitation clinicians monitor and encourage their patients to participate in therapy to optimize outcomes (1D).

Rationale

There is evidence that functional and medical outcomes after SCI are related to length of stay and the type of medical and rehabilitation management received. Among similar cohorts of individuals with SCI, access to a specialized SCI system of care was associated with comparatively greater functional outcomes and fewer major medical complications (Divanoglou et al., 2010). In particular, access to a specialized multidisciplinary SCI rehabilitation program was strongly predictive of functional outcomes (Richard-Denis et al., 2018).

In most SCI injury severity or level classifications, those who have had the benefit of a longer length of stay have greater functional independence at the time of discharge from acute rehabilitation (Kao et al., 2022). A number of skills that are essential to functioning in the home and community are improved to a greater extent in those with longer lengths of stay. These skills include bowel management, bed mobility, manual wheelchair skills, and use of the stairs (Morrison and Stanwyck, 1999). Longer lengths of stay are associated with lower rates of rehospitalization and lower pain levels during functional skills after discharge (DeJong et al., 2013; Eastwood et al., 1999; Morrison and Stanwyck, 1999).

In a retrospective medical record review of 262 patients, more intensive therapy (defined as hours per week) was associated with higher scores on a measure of functional independence and shorter length of stay (Truchon et al., 2017). Although injury characteristics explain much of the variance in outcomes after SCI (Whiteneck et al., 2012), among those with similar injury characteristics, the amount of time spent training on various activities in physical and occupational therapy contributes to differences in outcomes (Teeter et al., 2012; Ozelie et al., 2012).

Among patients in inpatient rehabilitation with motor-complete low tetraplegia (C5-8), more physical therapy time spent on manual wheelchair mobility is associated with greater skill in transfers at discharge, and more time spent working on transfers is associated with greater skill in transfers at 1 year after injury (Teeter et al., 2012). More occupational therapy time spent on lower body dressing, manual wheelchair mobility training, skin management, and bathing training is associated with greater functional independence in lower body self-care activities (lower body dressing, bathing, toileting, both at discharge from rehabilitation and at 1 year after injury; Ozelie et al., 2012).

Among patients in inpatient rehabilitation with motor-complete paraplegia (T1-9), more physical therapy time spent on endurance exercises and manual wheelchair mobility training is associated with greater functional independence at discharge, and more time working on strengthening exercises is associated with greater functional independence at 1 year after injury (Teeter et al., 2012). Greater amounts of occupational therapy time spent in training for clothing management and toileting hygiene are associated with greater functional independence in lower body self-care activities (Ozelie et al., 2012).

Although the early post-injury phase is associated with the most dramatic improvements in functional abilities, the potential to gain greater skill in all activities continues indefinitely (Field-Fote, 2020). Practice and training are essential for these improvements to occur, with preclinical evidence showing that even the most promising therapies are ineffective in the absence of training in animals with both acute (García-Alías et al., 2009) and chronic SCI (Torres-Espín et al., 2018).

Along with therapy dose, participation in physical and occupational therapy sessions during rehabilitation (as measured by therapist observation of patient behaviors that serve as a proxy for motivation) is associated with greater functional independence and greater likelihood of discharge to home and return to work or school (Teeter et al., 2012; Ozelie et al., 2012), as well as with a lower likelihood of rehospitalization (Ozelie et al., 2012). Higher use of rehabilitation services is associated with fewer hospital readmissions, and length of stay is a strong predictor of therapy dose (Canori et al., 2020).

Many factors beyond dose of therapy may have the potential to influence functional outcomes. A systematic review that included 15 studies identified a number of factors that require further exploration to understand how they influence functional outcomes. Common factors for which influence of functional outcomes in not definitively known include presence of spasticity, presence of depression or anxiety, days of interruption to functional rehabilitation, and intensive care length of stay (Richard-Denis et al., 2018).

Highly influential practice-based studies with large numbers of participants show that patient motivation, as operationalized by therapist ratings of participation, affects outcomes (Ozelie et al., 2012; Teeter et al., 2012). Any therapy that involves behavior is likely to be influenced by similar processes. Therefore, to better understand the efficacy of therapy outcomes in real-world settings, it would be useful to understand the degree to which the patient or subject appeared to take part in the intervention (Lequerica and Kortte, 2010).

There is an enormous scientific field on the principles and practice of effective health behavior change (Miller and Rollnick, 2013). Greater collaboration between rehabilitation therapists and psychologists or other behavior change experts can potentially improve the reach and effectiveness of rehabilitation therapies.

3.16 Traumatic vs. Nontraumatic SCI

Panel Findings

- Traumatic and nontraumatic SCI have similar functional outcomes when adjusted for age, injury level, and severity.
- Rehabilitation benefits both people with SCI regardless of etiology, with traumatic SCI linked to longer hospital stays and different complication patterns compared to nontraumatic SCI.

Synopsis of the Evidence

Although the majority of this CPG discusses SCI of traumatic etiology, because of the depth of literature on this topic, it is also important to consider outcomes related to nontraumatic SCI. According to the SCI Model Systems, traumatic SCI is defined as impairment of the spinal cord or cauda equina function resulting from the application of an external force of any magnitude. This may include auto accidents encountered with vehicles, gunshot wounds, penetrating wounds, person-to-person contact, explosions, sports and recreation, falls, being hit by falling or flying objects, or adverse effects of medical, surgical, or diagnostic procedures and treatment.

Recommendations for Research

1. Research and policy must prioritize innovative strategies and sustainable resources to strengthen caregiver support systems and ensure long-term well-being for individuals with severe physical limitations due to SCI and their families. Caregiver support is essential to ensure they receive the assistance required for their daily needs, health, and even survival with dignity and consistency. Without adequate support, both individuals and their families face overwhelming physical, emotional, and financial strain. Caregivers provide not only practical assistance but also critical emotional connection that enhances quality of life. Investing in caregiver support strengthens communities by promoting inclusion, reducing healthcare costs, and sustaining the well-being of those most in need.

2. Research is needed to delineate factors that predict actual mobility outcomes and community ambulation beyond characterizing walking vs. wheeling as a dichotomous outcome.

3. Research is needed to develop and use evidence-informed protocols and assessments to reduce health care disparities in marginalized populations.

4. Research is needed to understand the relationship between sociocultural constructs (e.g., sex, gender, ethnicity, and race) and access to pain management.

5. Research is needed to increase physical activity and to understand the impact of physical activity on physical and mental health and functioning.

6. Research is needed to examine the prevalence and impact of cognitive impairment associated with SCI, along with underlying causes and prevention.

7. Research is needed to understand and address the reason for greater levels of rehospitalization and pain among those with shorter rehabilitation lengths of stay.

8. Research is needed to further determine the influence of spasticity, depression, and anxiety on functional outcomes.

9. Research is needed to characterize the relationship between patient participation in rehabilitation therapies and functional outcomes and to develop strategies for increasing participation and motivation if warranted.

10. Research is needed to understand the relationship between mental health conditions and functional outcomes, as well as the mechanisms underlying the relationships.

Paralysis secondary to a progressive disease with no traumatic event such as a herniated disc or transverse myelitis or from a pathological medical condition of the vertebral spinal column such as rheumatoid spondylitis, spinal tumors, and Paget's disease would be considered nontraumatic SCI (Chen et al., 2016). An international data set for nontraumatic SCI and a comprehensive list and classification for the various etiologies is available (New et al., 2014).

In a retrospective study, 380 participants were studied during their first inpatient rehabilitation stay following SCI, of whom approximately two-thirds had an SCI of nontraumatic etiology. When outcomes were adjusted for age, level, and severity of injury, no differences were found in neurological and functional improvement as measured by the Barthel Index, Rivermead Mobility Index, and Walking Index for Spinal Cord Injury (Scivoletto et al., 2011). Generally, individuals with nontraumatic injuries were older than those with traumatic injuries, and this may be the factor that affects their outcomes vs. the nontraumatic etiology (Scivoletto et al., 2011).

Conflicting results were found in a study of over 1,300 participants (>80% nontraumatic SCI) where better neurological recovery was found in the nontraumatic group. However, this study did not correct for confounding variables such as age, AIS classification, and level of injury (Catz et al., 2004). Another study of 174 participants, approximately 40% nontraumatic SCI, showed potential for improvement from rehabilitation, as measured by AIS at admission and discharge, regardless of etiology. Individuals with traumatic SCI had an additional 3.4 weeks of length of stay. Length of stay was influenced by complications such as incidence of UTIs, which were more frequent in those with traumatic SCI, and PIs, which were more frequent in those with nontraumatic SCI (Gedde et al., 2019). A clinical prediction rule for walking that was developed from individuals with traumatic SCI (van Middendorp et al., 2011) was applied to a smaller cohort of 50 participants with nontraumatic SCI (Sturt et al., 2020). Findings show it well predicted those who would not walk, but was less accurate in predicting who would walk, particularly among those with incomplete injury (Sturt et al., 2020).

Recommendations

3.16.1 We recommend that clinicians consider prognostic indicators described for traumatic SCI when developing a plan of care for individuals with either traumatic or nontraumatic SCI (1D).

Rationale

In a study comparing traumatic and non traumatic SCI, traumatic cases were more common in younger men and caused by accidents, while non traumatic cases were linked to conditions like tumors or inflammation (Mackiewicz-Milewska et al 2025; n=176). Traumatic injuries were generally more severe, involved more cervical damage, required more surgery and wheelchair use, and led to longer rehabilitation, highlighting distinct differences in outcomes between the two groups. However, when adjusted for confounding factors such as age, level of injury, and injury severity, evidence suggests that neurological and functional outcomes do not differ between traumatic and nontraumatic SCI (Scivoletto et al., 2011; Gedde et al., 2019).

Clinicians should continue to consider prognostic indicators for SCI, as discussed in Section 1 (Neurological Outcomes) and Section 2.7 (Walking) of this CPG when determining prognosis for individuals with both traumatic and nontraumatic SCI. While the ISNCSCI was developed for classification of neurologic status in people with traumatic SCI, a study of individuals with non-traumatic SCI found the ISNCSCI had strong internal consistency and substantial inter-rater reliability across key measures. Motor scores correlated with SCIM subscores, confirming ISNCSCI as a valid and reliable assessment tool for this population (Lena et al, 2022; n=140). Clinical prediction rules (van Middendorp et al., 2011) can be applied to individuals with nontraumatic SCI, though with caution, as these rules were more accurate in predicting who would not walk vs. who would walk in this population (Sturt et al., 2020).

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Appendix

Key Questions identified by the panel comprising the Paralyzed Veterans of America Outcomes document with search terms embedded

1

A. Neurological recovery (ISNCSCI)

1. What percentage of people recover AIS grades?

Search terms: spinal cord injury, AIS score, AIS grade, recovery, percentage of recovery, severity of injury, level of injury

2. What percentage of people recover 1 or more levels?

Search terms: spinal cord injury, AIS grade, AIS score, recovery, percentage of recovery, level of injury, severity of injury

3. What is the expected progression of neurological level of injury related to the ZPP?

Search terms: spinal cord injury, neurological level of injury, zone of partial preservation (ZPP), level of injury, severity of injury, AIS grade

4. What are the characteristics that predict outcomes (e.g., pinprick vs. light touch scores)?

Search terms: spinal cord injury, outcomes, predictors of outcomes, predictors of recovery, pinprick scores, light touch (LT) scores, severity of injury, level of injury, AIS score, AIS grade, upper extremity motor score (UEMS), lower extremity motor score (LEMS)

B. Functional independence outcomes (by level of injury for people, severity)

1. Respiratory, bowel, bladder, and sexual health

2

a. What are the factors associated with better respiratory outcomes?

Search terms: spinal cord injury, respiratory, breathing, outcomes, function, predictors, factors

3

b. What are the factors associated with better bowel outcomes?

Search terms: spinal cord injury, bowel, constipation, incontinence, outcomes, bowel management, neurogenic bowel dysfunction (NBD), predictors, factors

4

c. What are the factors associated with better bladder outcomes?

Search terms: spinal cord injury, bladder, incontinence, outcomes, bladder management, neurogenic bladder, predictors, factors

d. What are the factors associated with better sexual health outcomes?

Search terms: spinal cord injury, sexual health, outcomes, erection, ejaculation, pregnancy, orgasm, labor, fertility, infertility, predictors, factors

5

2. Seated activities (bed mobility, bed/wheelchair transfers, and positioning/pressure relief)

a. What injury characteristics (level, severity) predict seated mobility outcomes?

Search terms: spinal cord injury, level of injury, severity of injury, predictors, factors, seated mobility, wheeled mobility, outcomes, wheelchair, transferring, transfers

3. Walking

a. What are the prognostic indicators that predict walking outcomes?

Search terms: spinal cord injury, walking, mobility, predictors, factors, indicators, outcomes, ambulation, AIS, 6-minute walk test, 10meter walk test, lower extremity motor score (LEMS)

b. Does participation in locomotor training in the inpatient rehabilitation phase influence walking outcomes?

Search terms: spinal cord injury, locomotor training, walking, outcomes, inpatient rehabilitation, ambulation, gait, 6-minute walk test, 10-m walk test, lower extremity motor score (LEMS)

c. What is the relationship between injury characteristic and lower extremity assistive device use?

Search terms: spinal cord injury, level of injury, severity of injury, assistive device, lower limb, cane, knee ankle foot orthosis (KAFO), ankle foot orthosis (AFO), exoskeleton, braces, walkers, orthoses, assisted walking, robotics

4. Arm and hand function (eating, grooming, dressing, and bathing)

a. What characteristics of acute injury predict change in impairment scores?

Search terms: spinal cord injury, upper extremity motor score (UEMS), arm, hand, activities, outcomes, predictors, factors, impairment, AIS grade, AIS score, activities of daily living (ADLs)

b. What characteristics predict arm/hand activity outcomes?

Search terms: spinal cord injury, upper extremity motor score (UEMS), arm, hand, activities, outcomes, predictors, activities of daily living (ADLs)

c. Does participation in an activity based in arm/hand training in inpatient rehabilitation influence upper extremity outcomes?

Search terms: spinal cord injury, arm training, hand training, inpatient rehabilitation, upper limb outcomes, movement, upper extremity motor score (UEMS), activities of daily living (ADLs)

6

5. Driving

a. What characteristics (physical and cognitive) predict driving outcomes?

Search terms: spinal cord injury, level of injury, severity of injury, driving, ability to drive, car, assisted driving, adaptive vehicle, predictors, factors, physical ability, cognitive ability, tetraplegia, paraplegia, accessible transportation, vehicle modifications

6. Skin care behaviors (e.g., pressure relief, skin checks, proper positioning, limiting uptime)	
	a. What are skin health outcomes after SCI, including rehospitalization? Search terms: spinal cord injury, skin health, pressure ulcers, pressure sores, pressure relief, rehospitalization, predictors, factors, outcomes, tetraplegia, paraplegia
	b. What are the characteristics of people who are at higher risk for skin health issues? Search terms: risks, high risk, spinal cord injury, skin health, pressure ulcers, pressure sores, pressure relief, rehospitalization, predictors, outcomes, tetraplegia, paraplegia, factors
	c. What is adherence to skin health recommendations among those with SCI? Search terms: adherence, treatment recommendations, spinal cord injury, skin health, pressure ulcers, pressure sores, pressure relief, rehospitalization, predictors, outcomes
	d. How do skin health issues affect function? Search terms: function, outcomes, spinal cord injury, skin health, pressure ulcers, pressure sores, pressure relief, rehospitalization, predictors, outcomes
7. Wheeled mobility	
	a. What are characteristics of injury that predict manual, power, or power-assisted wheelchair use and needs? Search terms: spinal cord injury, manual wheelchair, power wheelchair, transfers, floor to chair, chair to bed, chair to toilet, injury level, severity of injury, tetraplegia, paraplegia
	b. Does wheelchair propulsion training affect outcomes? Search terms: spinal cord injury, training, wheelchair skills, wheelchair training, wheelchair propulsion, level of injury, severity of injury, function, outcomes, upper body impairments, wheelchair capacity
C. Quality of life	Only systematic reviews searched
	1. What are the biopsychosocial characteristics of individuals with SCI that affect health-related quality of life? Search terms: review, systematic review, spinal cord injury, quality of life (QOL), biological, social, psychological, biopsychosocial, health-related QOL, outcomes, predictors, systematic reviews, satisfaction, life satisfaction
	2. Do QOL outcomes differ depending on level or severity of injury (see modifiers)? Search terms: review, systematic review, spinal cord injury, quality of life (QOL), level of injury, severity of injury, outcomes, life satisfaction, participation, predictors, factors, tetraplegia, paraplegia

D. Community reintegration (including return to school/work).	Only systematic reviews searched
Sys. Revs.	**1. What are the biopsychosocial characteristics of individuals with SCI that are associated with community reintegration?** Search terms: review, systematic review, spinal cord injury, biopsychosocial, predictors, factors, outcomes, community integration, community reintegration, participation, level of injury, severity of injury
	2. What percentage of individuals with SCI return to part-time/full-time work/ school? Search terms: review, systematic review, spinal cord injury, work, employment, school, percentage, education, return to work, return to school, level of injury, severity of injury, tetraplegia, paraplegia
	3. What are key factors that influence return to school/work after SCI? Search terms: review, systematic review, spinal cord injury, work, employment, school, factors, education, predictors, level of injury, severity of injury, return to work, return to school

II. Outcome modifiers (correlations identified in the literature)

A. Attitudinal and environmental factors	
	1. How are race, ethnicity, sex, racism, sexism, agism, ableism, and implicit bias associated with differential outcomes? Search terms: spinal cord injury, race, ethnicity, sex, age, bias, implicit bias, outcomes, health outcomes, access to care, gender, transgender, sexual orientation, minorities, disparity
	2. What is the relationship between transportation barriers and outcomes? SCIRE did not search this question and the panel used clinical judgement
	3. What is the relationship between the built environment and outcomes? SCIRE did not search this question and the panel used clinical judgement
B. Spasticity	
	1. What is the relationship between spasticity and function? Search terms: spinal cord injury, spasticity, function, outcomes, functional outcomes, predictors, factors, level of injury, impairment, tremor, spasms, “good” spasticity, “bad” spasticity, problematic spasticity

C. Pain

1. **What is the relationship between pain and function**

Search terms: spinal cord injury, pain, function, outcomes, functional outcomes, predictors, health care access, rehospitalization, level of injury, severity of injury

2. **Are there differences in pain management access/equity based on sex or race?**

Search terms: spinal cord injury, pain, function, outcomes, functional outcomes, predictors, access, access to care, equity, sex, gender, race, level of injury, severity of injury

D. Bone density – instructed to extract information from the recently published Consortium for Spinal Cord Injury Bone CPG

1. **What are the factors that relate to bone fragility?**
2. **Cite BMD CPG regarding threshold for fracture risk**

E. Health management behaviors/adherence

1. **What factors are associated with successful health management in individuals with SCI (self-management or direct care partners)?**

SCIRE did not search this question and the panel used clinical judgement

F. Pre/comorbid mental health conditions (e.g., depression, anxiety, PTSD, substance use disorders)

1. **What is the relationship between comorbid mental health conditions and function?**

Search terms: spinal cord injury, depression, anxiety, PTSD, substance use, substance abuse, substance use disorders, post-spinal cord injury, drug abuse, addiction, psychological well-being

G. BMI and body habitus

1. **What is the relationship between BMI/body habitus and mobility outcomes?**

Search terms: spinal cord injury, body mass index, body habitus, mobility, outcomes, cardiometabolic syndrome, cardiometabolic risk, cardiorespiratory, obesity, predictors, functional outcomes, underweight, overweight, metabolic syndrome, waist circumference, adipose tissue, cardiovascular disease (CVD), level of injury, severity of injury, morbidity, mortality

2. **What is the relationship between cardiorespiratory/metabolic syndrome and health outcomes?**

Search terms: spinal cord injury, body mass index, body habitus, mobility, outcomes, cardiometabolic syndrome, cardiometabolic risk, cardiorespiratory, obesity, predictors, functional outcomes, underweight, overweight, metabolic syndrome, waist circumference, adipose tissue, cardiovascular disease (CVD), level of injury, severity of injury, morbidity, mortality

H. Physical inactivity/deconditioning/sedentariness

1. **What is the relationship between physical inactivity and function/outcomes?**

Search terms: spinal cord injury, physical activity, physical inactivity, deconditioning, sedentariness, function, mobility, outcomes, predictors, functional outcomes, level of injury, severity of injury, morbidity, mortality, exercise

I. Age

1. **How does age influence outcomes?**

Search terms: spinal cord injury, age, aging, outcomes, predictors, elderly, time since injury, duration of injury, older adults, longitudinal, morbidity, mortality

J. Care partner and social support

1. **How does care partner/social support influence outcomes?**

Search terms: spinal cord injury, care, caregiver, care partner, social support, outcomes, emotional support, psychological support, paid care, paid caregiving, family caregiver, family support, attendant care, delivery of care, home health aides, personal support

K. Cognition (cognitive impairment, neurocognitive influences)

1. **What is the relationship between comorbid cognitive impairment and function?**

Search terms: spinal cord injury, traumatic brain injury (TBI), cognitive, cognition, cognitive impairment, dual diagnosis, acute

L. Concomitant orthopedic/musculoskeletal/neuro injury

1. **What is the relationship between acute multitrauma and outcomes after SCI?**

SCIRE did not search this question and the panel used clinical judgement

2. **What is the relationship between overuse injury and functioning in chronic SCI?**

Search terms: spinal cord injury, overuse, shoulder pain, training, joint preservation training, shoulder training, transferring, pain, level of injury, severity of injury

M. Use of assistive technology

1. What is the relationship between equipment (wheeled mobility, adapted driving technology), assistive technology, adaptive technology (environmental controls), and functional outcomes?

Search terms: spinal cord injury, assistive technology, adaptive technology, function, outcomes, functional outcomes, computers, accessibility, disability technology, tetraplegia, paraplegia.

Additional search terms: smart home, smart device, smart technology, home functioning, activities of daily living (ADLs), functional outcomes, environmental control system, electronic aid, Independence, environmental controls, touch screen, virtual reality, brain-computer interface

*Wheeled mobility and driving have their own dedicated sections, and so that information was included there.

2. How has environmental control (smart home) technology changed home functioning?

Search terms: spinal cord injury, smart technology, function, functioning in the home, homemaking, outcomes, home technology

N. Changes since 1999 CPG

1. How has training changed since the previous Outcomes CPG (e.g., transfer training, loading wheelchair, propulsion training) and how has this affected outcomes?

SCIRE did not search this question and the panel used clinical judgement

O. Socioeconomic status

1. What is the relationship between socioeconomic status and outcomes?

Search terms: spinal cord injury, socioeconomic status (SES), income, outcomes, payer/provider, insurance, disparity, disability, private insurance, worker's compensation, level of injury, severity of injury

2. What is the relationship between education and outcomes?

Search terms: spinal cord injury, education level, education, outcomes, level of injury, severity of injury

3. How is access to care, including payer source and availability of providers, associated with outcomes?

Search terms: spinal cord injury, access, care, access to care, Medicaid, Medicare, private insurance, outcomes, do people do better with public or private insurance, payer/provider, workers' compensation, disparity

P. Influence of standard rehabilitation

1. What is the relationship between length of stay and functional outcomes?

Search terms: spinal cord Injury, length of stay, rehabilitation, function, outcomes, functional outcomes, predictors, factors

2. What is the relationship between dose of therapy and functional outcomes?

Search terms: spinal cord injury, length of stay, rehabilitation, dose of therapy, function, outcomes, functional outcomes

3. How does therapy participation influence outcomes?

SCIRE did not search this question and the panel used clinical judgement

Q. Traumatic vs nontraumatic

SCIRE did not search this question and the panel used clinical judgement