



## Review Article

# Translating promising strategies for bowel and bladder management in spinal cord injury



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## ABSTRACT

Loss of control over voiding following spinal cord injury (SCI) impacts autonomy, participation and dignity, and can cause life-threatening complications. The importance of SCI bowel and bladder dysfunction warrants significantly more attention from researchers in the field. To address this gap, key SCI clinicians, researchers, government and private funding organizations met to share knowledge and examine emerging approaches. This report reviews recommendations from this effort to identify and prioritize near-term treatment, investigational and translational approaches to addressing the pressing needs of people with SCI.

## 1. Introduction

Restoring bowel and bladder function following spinal cord injury (SCI) is a top consumer and research priority (Anderson, 2004; Ditunno et al., 2008; Liu et al., 2009; Braaf et al., 2017). Unfortunately, current levels of research activity and emerging translational approaches do not reflect this importance. The inability to control voiding is a persistent problem for persons with SCI that reduces participation in activities and deprives them of privacy and dignity. Because of the clear impact bowel and bladder dysfunction has on the quality of life of these individuals, the Craig H. Neilsen Foundation conducted a workshop to identify, target and accelerate research areas ready for translation. This report provides an overview of recommendations developed during the workshop, reviews current efforts that arose from the workshop, and provides descriptions of activities needed from the larger community to advance promising strategies for bowel and bladder management after

## SCI.

Experts in SCI urogenital research, physiology, autonomic function, biomedical engineering, clinical care, and patient advocacy formed an advisory committee to assist in developing the workshop agenda, participant list and plans to disseminate workshop outcomes (Appendix 1). The event was held March 3–4, 2017 in Washington, D.C. with three main goals: identify the most promising approaches for which a 10-year translational timeline would be considered both reasonable and achievable; bring together researchers and clinicians to exchange information and increase communication and cooperation between them; and build collaborations between leaders in medical, industrial, patient advocacy, research, regulatory and funding organizations to accelerate future approaches that provide more effective treatment options.

Participants worked in small groups on structured roadmap building activities to develop a list of focus areas. First, clinicians, consumer representatives and industry representatives shared their research and

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experience to present the issues. Next, breakout groups shared additional insight, deliberated and prioritized issues into a list of problems to solve. Throughout the workshop, focus was directed to the most pressing constituent needs and identification of opportunities to address these needs. Small group recommendations were presented and discussed at the end of the two-day event. Interestingly, 5 out of the 6 small groups identified the same first step for improving bowel and bladder management. This recommendation, to identify and disseminate treatment guidelines, was described as readily achievable.

As the main outcome of the workshop, these working groups developed collective recommendations that were organized into five thematic areas. They range from steps described as immediately achievable to areas that require further investigation and longer development timelines. Recommendations also span broad but distinct skill areas such as communication and biomedical engineering.

## 2. Summary of recommendations

Theme/focus Area	Description
Education & clinical care standards	Update, disseminate, and provide guidance to consumers and clinicians on current therapeutic approaches. Create a consumer profile to characterize needs, including lifestyle and poly-pharmacy.
Bowel physiology	Prioritize efforts to understand gastrointestinal physiology to elucidate the effects of SCI and therapeutic interventions on bowel function, including its relationship to the urinary system.
Sensory awareness	Identify technology and approaches that can measure key indicators of the need to void or system dysfunction and thereby enable patient awareness in daily activities and potential for improved diagnosis.
Neuromodulation	Use existing systems or create novel technologies that can replace or restore control of gastrointestinal and urinary system functions.
Rehabilitation activity & exercise	Quantify evidence and build an understanding of how seemingly unrelated approaches (e.g., exoskeletons, treadmills, overground walking, and other therapies) have a positive effect on bowel and bladder function.

### 2.1. The problem and how it is managed

Neurogenic bladder is a broad term for bladder and sphincter dysfunction due to a neurological disease or condition. In SCI, urologic clinical manifestations depend on the level and extent of the injury (Wein and Dmochowski, 2011). A complete lesion above the sacral spinal cord results in detrusor overactivity, smooth muscle sphincter dyssynergia and striated muscle sphincter dyssynergia. Striated sphincter dyssynergia will result in an obstruction with high detrusor pressure and poor bladder emptying. Sacral SCI will usually demonstrate bladder atony or areflexia with normal or high bladder compliance (elasticity). Decreased compliance may develop, which can lead to hydronephrosis and irreversible kidney damage.

In practice, SCI neurogenic bladder dysfunction's presentation is as varied as the individuals affected with SCI, almost all of whom face a struggle to manage this condition on a day-to-day basis. A key issue was described as the inability, for those with SCI, to detect rising bladder pressure or bladder fullness in a "closed loop system." Additionally, the

level of injury was also discussed in its relationship to symptomatic presentation and intervention targets. "The Functional System" describes the bladder dysfunction in terms of occurring in the filling/storage or emptying/voiding phase of micturition (Wein and Barrett, 1988). This classification, generally divided into "Failure to Store" and "Failure to Empty," has been expanded to include specific urodynamic findings based upon the activity of the detrusor and sphincter outlet noted as either hyperreflexic, normoreflexic, or areflexic (Krane and Siroky, 1984). These three classifications define the main therapeutic targets: failure of storage (incontinence), failure to empty or a combination of the two. Each condition could be due to dysfunction of the bladder, the sphincter, or both.

Urological systems are fairly well described in the scientific literature (de Groat et al., 2015), which enabled robust discussions regarding the appropriateness and effectiveness of long-term treatment options. Clinicians described their standard practices for developing a bladder management strategy for consumers with SCI, which they admitted rely heavily on where they conducted their residency and what options they had experience with. Non-electrical devices comprise the majority of supportive technology used in standard practice. These devices are either catheters (intermittent and indwelling (e.g., Foley)) or stents (prostatic and urethral). Surgical approaches were described as an option recommended only when patients expressed deep dissatisfaction with their current management approach. Surgical options include sphincterotomy, bladder enlargement (i.e., augmentation cystoplasty), urinary diversion or cystectomy to by-pass the bladder and lumbar sacral rerouting. Botulinum toxin injections are often used to relax the bladder and this option is growing in popularity due to the reversible nature of this approach. Workshop participants also received an overview of emerging, and hence, less commonly utilized electrical approaches to restore bladder function. The biological targets include stimulation at the level of the spinal cord, spinal nerve roots, peripheral nerves or muscles of the bladder wall and sphincter. These targets are reached via a multitude of stimulation modalities, including pharmacological, ultrasonic, magnetic, or electrical delivered through devices (i.e., surface and implanted) (Gaunt and Prochazka, 2006) or pharmacological routes of administration (e.g., oral, rectal). Hence, a wide range of options need to be considered, in relation to both clinical effectiveness and patient preference.

Neurogenic bowel is a colonic dysfunction resulting from a lack of central nervous control of the gastrointestinal tract (Krassioukov et al., 2010a, 2010b). This condition is commonly observed in individuals with SCI and clinically presents as two distinct patterns of bowel dysfunction; injury above the conus medullaris results in upper motor neuron bowel syndrome and injury at the conus medullaris and cauda equina results in lower motor neuron bowel syndrome (Krassioukov et al., 2010a, 2010b). Upper motor neuron bowel syndrome is characterized by high pressure and lost coordination of rectal contractions that result in a failure to relax the anal sphincter. Lower motor neuron bowel syndrome is characterized by areflexic rectum and low anal sphincter pressure. Both of these conditions have been shown to reduce transit through the colon. Similar to bladder, failure to store (fecal incontinence) and empty could be due to either/both bowel or sphincter dysfunction. Neurogenic bowel dysfunction is a major physical and psychosocial problem for individuals with SCI, as changes in bowel motility and sphincter control are coupled with impaired mobility and loss of hand dexterity. The clinical management approach to bowel dysfunction after SCI is overwhelmingly the use of digital stimulation (Stiens et al., 1997; Correa and Rotter, 2000; Yim et al., 2001; Krassioukov et al., 2010a, 2010b). This was described as the routine practice in therapy and, in many centers, demonstrated success is required prior to hospital release. *trans*-Anal irrigation is utilized more commonly in Europe than in the US, and is mainly used when other approaches fail (Emmanuel, et al., 2013). The primary goals of therapy are to reduce the amount of time spent on defecation, minimize fecal incontinence and reduce the impact of bowel management on quality of

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