

Brief report

# Independent sailing with high tetraplegia using sip and puff controls: integration into a community sailing center

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**Background:** We are continually rediscovering how adapted recreational activity complements the rehabilitation process, enriches patients' lives and positively impacts outcome measures. Although sports for people with spinal cord injuries (SCI) has achieved spectacular visibility, participation by high cervical injuries is often restricted due to poor accessibility, safety concerns, lack of adaptability, and high costs of technology.

**Methods:** We endeavor to demonstrate the mechanisms, adaptability, accessibility, and benefits the sport of sailing creates in the rehabilitative process. Our sailor is a 27-year-old man with a history of traumatic SCI resulting in C4 complete tetraplegia.

**Results:** The participant completed an adapted introductory sailing course, and instruction on the sip-and-puff sail and tiller control mechanism. With practice, he navigated an on-water course in moderate winds of 5 to 15 knots.

**Discussion:** Despite trends toward shorter rehabilitation stays, aggressive transdisciplinary collaboration with recreation therapy can provide community and natural environment experiences while inpatient and continuing post discharge. Such peak physical and psychological experiences provide a positive perspective for the future that can be shared on the inpatient unit, with families and support systems like sailing clubs in the community.

**Conclusion:** Rehabilitation theory directs a team process to achieve patient self-awareness and initiate self-actualization in spite of disablement. Utilization of local community sailing centers that have provided accessible assisted options provides person-centered self-realization of goals as assisted by family and natural supports. Such successful patients become native guides for others seeking the same experience.

**Keywords:** Spinal cord injury, Tetraplegia, Adaptive sailing, Recreation therapy, Community reintegration, Nature

## Introduction: sailing as an accessible sport for tetraplegia

Participation in sports, whether recreational or therapeutic in nature, has been included as an integral part of the rehabilitation of individuals living with spinal cord injuries (SCI).<sup>1-6</sup> Paralysis makes people with SCI one of the most inactive sectors of society. They are particularly prone to the deleterious effects of a sedentary lifestyle.<sup>7</sup> Increasing physical activity in this population

has demonstrated to be vital in the development and maintenance of cardiovascular fitness, mental and emotional resilience, social wellbeing, participation, and a sense of community belonging.<sup>3,8-13</sup> Additionally, research has demonstrated that the benefits of exercise in various patient populations, including improved muscle strength and endurance, decreased insulin resistance, and a decreased risk of cardiovascular mortality may all carry over to the SCI population.<sup>14</sup>

The growing body of work reinforcing the benefits of physical activity in the SCI population has also nurtured the creation of numerous adaptive sports model programs. Yet overall, approximately two-thirds of

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individuals with physical disabilities in the United States do not participate in sports, while approximately one-third of individuals without disabilities do not participate in sports.<sup>15</sup> By contributing to the growth of individual functional independence, sports may have positive associations with employment with the added benefits of improved self-efficacy, mood management, reduced depressive symptoms, less stress and improved psychological adjustment.<sup>16–21</sup> However, the stigma associated with the perceived medical, emotional, organizational, and environmental obstacles to participation often continues to mask the perceived benefits.<sup>22,23</sup>

As the relationship between lower level injuries, exercise, and sport has been increasingly examined, understanding the relationship between physical activity and higher-level SCI has often been limited by several barriers, including medical complexity, underdeveloped adaptive technology and insufficient awareness of opportunities. More recently, research has indicated that people with tetraplegia do benefit from training programs and sports participation aimed at increasing strength, decreasing fatigue, and improving pulmonary and cardiac risk factors.<sup>24–27</sup>

We have endeavored to demonstrate the beneficial effects of the sport of adaptive sailing as part of the rehabilitation of an individual with a chronic, high-level SCI. The perception of sailing as dangerous, financially burdensome, inaccessible and over-strenuous has often misled individuals with injury in their pursuit of sport and recreation.<sup>28</sup> Advancements in technology and safety, including the use of the sip-and-puff control mechanism, may further circumnavigate barriers to participation in addition to enhancing quality of life.

## Case presentation: gymnast recovered to C4 ASIA A SCI

### History

This 27-year-old, right-handed single man endured a C4-5 fracture during a gymnastics tumbling exercise. He reported immediate severe neck pain and inability to move his arms and legs. Examination demonstrated complete motor and sensory tetraplegia and radiography revealed a fracture dislocation of the C4-C5 vertebrae with retropulsion of C5 severely compressing the spinal cord. He then underwent anterior cervical discectomy at C4-5 with anterior and posterior fusion at C4-5. Approximately four months after the spinal cord contusion, an initial outpatient evaluation at the International Center for Spinal Cord Injury confirmed a C4 ASIA (American Spinal Injury Association) A. Manual muscle testing revealed 2/5 strength in elbow flexion on the left with all other ASIA motor

scores being 0/5. Sensation was noted to be intact to pinprick and light touch bilaterally throughout the C4 dermatome (all points proximal to the acromioclavicular joints). Motor evaluation of the cranial nerves indicated intact strength, including symmetric shoulder shrug and head turning.

### Outpatient rehabilitation and care

At the time of initial evaluation, the patient required total assistance with all activities of daily living (ADLs), feeding, toileting, transferring and mobility. Rehabilitation included several courses of activity-based restorative therapy (ABRT), comprised of skilled occupational, physical and aquatic therapies. He then progressed to a primarily home-based course of therapeutic activity. Currently, the patient continues to direct all of his care, including activities of daily living, and works with a 24-hour attendant and family members who support bowel, bladder, skin care, and mobility. He endures rare symptoms of autonomic dysreflexia in the past with blood pressure elevation up to 199/98, facial flushing, diaphoresis, and nausea associated with fever, likely due to Foley catheter dysfunction and overheating. These episodes were noted to be remote and infrequent. Upper and lower extremity spasms are frequently triggered by movement or position change, although have not been noted to cause pain nor interfere with activities of daily living. Multiple, regular physician follow-ups revealed no evidence of depressive symptoms or suicidal ideation.

### Introduction to adaptive sailing: assessment of impairment, adaptation and demonstration

Prior to the injury, the participant was active with the Boy Scouts of America and was able to achieve the Sailing Merit Badge. Passion for the outdoors and the desire to pursue leadership roles motivated him to achieve his goal of becoming an Eagle Scout. He endorses a fondness for sailing although he denies participating in any major sailing events due to the lack of accessibility. Regular family camping trips helped implant early connections to nature and bolstered his adventurous spirit. He notes that while growing up, it was his desire to participate “in every, and any sport possible”, including but not limited to baseball, track, volleyball and gymnastics. The patient was reintroduced to basic sailing techniques and objectives. He then participated in on-land, classroom style sessions to facilitate understanding of the sport. In addition to receiving classroom education on sailing, he was trained in use of the sip-and-puff mechanism and new adaptation control.

## Methods and materials

Basic sailboat (or keelboat) instruction began with classroom sessions on basic terminology, operations, preparations, equipment, techniques and maneuvers, sailing environments, and safety concerns. Highlights of basic sailing instruction include the use of a tiller, or lever arm, to control the boat's rudder, which is the lengthened foil at the back of the boat that affords directionality to the sailor, as well as understanding the concept of trimming, or adjusting, the sails to achieve maximum push or pull on the sailboat.<sup>29</sup> The Baltimore Downtown Sailing Center (DSC) is a non-profit sailing center offering sailing instruction and access various sailing activities through a variety of programs offered to the Baltimore area for over 20 years.<sup>30</sup> The fleet owned and operated by the DSC includes numerous vessels available for adaptive sailing. Ten feet long and capable of carrying between 350 and 400 total pounds on board, the Access 303 keelboat is a single or double occupancy, single hull vessel often used by first-time sailors.<sup>29,31</sup> This particular type of sailboat is ideal for beginners as well as individuals with physical disabilities due to its easy maneuverability, ease of accessibility and low center of gravity which resists capsizing.

The Access 303 may be outfitted with different adaptations to provide for the needs of individuals with limited mobility. For individuals with severely limited mobility, such as those with higher-level tetraplegia, the boat may be rigged with a sip-and-puff mechanism to exact precise control of the boat through pneumatic operation of the tiller arm and servo-driven manipulation of both the main sail and the jib sail. Figure 1A – D depicts the sailor's transfer to the keelboat via dock-mounted Hoyer Lift and use of the sip-and-puff controls to navigate the boat on water. The chest-mounted sip-and-puff mechanism housing the ultra-portable, power-assist battery module is conveniently harnessed to the participant's life vest so that the straws are easily within reach of the sailor's lips. Certain units may also provide a wireless remote control option in the case of an individual who may desire to sail with a sip-and-puff sailor or an instructor on a nearby powerboat. A two-straw system is utilized in this case, each made of durable plastic material. Small sips and gentle puffs of air are required to activate each straw, either controlling the sails or the tiller.

The term sip-and-puff may actually be misleading in this case. Similar to a sip-and-puff-controlled power wheelchair, the operator is not required to exert forceful air movements such as when blowing up a balloon, but rather simply sealing the mouth around the straw and

creating either a slight pressure ("puff") or vacuum ("sip") can suffice in firing the pneumatic switches. All necessary functions are controlled by the sailor's breath. The right side straw controls the steering mechanism via the tiller connections to the rudder. The operator puffs to steer left and sips to steer right through the right straw. The left side straw adjusts the front sail, also known as the jib sail, puffing the sail out or sipping the sail in. Other equipment features and adaptive modifications are primarily aimed at creating the safest possible environment for the participant. The sip-and-puff controls distance the user from any conductive material associated with the device, thus eliminating the concern over the possibility of accidental electrical shock. The interior of the keelboat requires simple and easy to assemble adaptations consisting of special foam cushioning applied to the interior, so as to reduce the likelihood of skin irritation related to positioning and diminished sensory function. Furthermore, in addition to providing overwatch, staff members provide radio contact throughout the activity with a standard 2-way radio attached to the life vest. During the participant's first experience, he prepared with instruction and standard safety equipment as noted, in addition to further precautionary measures required as a result of SCI. To support the tetraplegic sailor, assistance with catheterization prior to and immediately after docking the boat, and ensuring adequate bowel care the previous evening or morning of the activity was necessary. Additional provisions, such as foam padding to prevent skin irritation, had been prepared and adequately lined the cockpit of the sailboat, both lateral to the sailor and in between his legs.

## Results: independent sailing, navigation and competition

Successful, safe, and independent keelboat operation and navigation occurred on two occasions in Baltimore's inner harbor. Optimal participation required an adaptive and functional interface between the patient and the environment. Ambient outdoor temperatures remained relatively stable at approximately 22 degrees Celsius with intermittent winds averaging nearly 10 knots throughout the afternoon. The participant was able to perform adequate pressure reliefs while at sea, including primarily side bends and forward leans. During the outings, he denied any symptoms of autonomic dysreflexia, although he noted having mild facial flushing and light sweating. Open communication was maintained between the sailor, the docking team, and the powerboat team keeping a



**Figure 1 A – D: Adaptive sailing.**

(A) The sailor is shown mid-transfer via Hoyer lift to the cockpit of the dinky. Special foam padding can be seen, as well as the chest-mounted sip-and-puff control mechanism. (B) The operator puffs to steer left and sips to steer right through the right straw. The left side straw adjusts the jib sail, puffing the sail out or sipping the sail in. Frames (C) and (D) display the sailor engaging the mechanism in controlling the boat, as well as participating in one of the races with family members boating in the background. 1 = Foam Padding; 2 = Dockside Hoyer Lift; 3 = Chest-mounted Sip-and-Puff Drive Mechanism; 4 = Control Straws; 5 = Jib Sail; 6 = Main Sail, 7 = Rudder (colour online)

close eye on all vessels. After brief periods of engaging the boat and testing its capabilities, the sailors then followed a course, approximately 1000 meters in length, which was marked off by buoys throughout the inner harbor. Family members in similar Access 303 dinghies also joined in various sailing activities, including friendly races on the marked course.

The physical achievements as well as the experience are important for person-centered physical and psychological adaptation.<sup>32</sup> Although he felt as though the sea had a generalized calming effect, he noted “being alone was a rush and flipping the boat was a real possibility”. The participant described a sense of control over the sailboat and highlighted a “return to nature” as one of the specific qualities inherent to the sport that specifically appealed to him. He went on to say: “It was great to get out there and compete again because I was out there doing this by myself. That I could get in

this boat and just go, and I didn’t have to rely on somebody else, it was just such a great feeling.” The participant noted excellent control via the sip-and-puff mechanism with a high degree of accuracy and precision in achieving the desired directionality and sail formation. Family described his experience as “... amazing to see sailing take away his disability. It just shows that he is making progress and that he is not giving up at all.” Family and staff were amazed to see him master the controls so quickly, so as to be able to outsail other able-bodied individuals and winning several of the races held on the course marked off near the DSC. His father noted that “it’s great to see he hasn’t lost his competitiveness.” As the participant was highly active prior to his injury, there was a certain level of excitement in returning to participate in sport. His return to sport sparked further interest at the idea of returning to coaching volleyball and future desires

to play wheelchair rugby. Following land-based instruction and on-water sailing activity, the participant noted improvements in mood, self-worth, community belonging, as well as a desire to return to adaptive sailing on a regular schedule in the future. He continued to enjoy a greater sense of community to the present day through continued involvement in multiple subsequent sailing events, in addition to being inspired to pursue other adaptive sports and coaching opportunities. Similarly, these emotional benefits have been described in both on-water and virtual sailing studies alike.<sup>28</sup> Primary measures did not include quantitative evaluations, although the participant was queried in interviews after sailing events. Subjective responses to the experience were reviewed for positive or negative effect and were unanimously positive. These positive effect were noted to be present a year after the initial sailing day during the participant's second adaptive sailing event. He was able to demonstrate improved function with the activity.

### **Discussion: outcomes of sailing as therapy**

This report highlights the case of a young man with high tetraplegia who was able to fulfill his desire to participate in sport attaining functional independence, safety, comfort and overall enjoyment. The novelty of this work lies in the presentation of the unique opportunity for motivated individuals to attempt sport that may have been previously perceived as inaccessible and unadaptable after high level SCI. Traversing the barriers that are often associated with on-water activity may facilitate integration of these activities into the rehabilitation program of similarly interested and motivated individuals. Sequential achievement with rehabilitation and mastery allows for improved function with the activity

Affording the individual with high cervical complete injury the opportunity to participate in an adaptive sailing program requires an infrastructure that extends from acute rehabilitation to on site sailing. In order to be able to provide for those individuals whose mobility is severely restricted, an adaptive sailing program should be able to provide commonly integrated facility adaptations, which include ramps, elevators, lifts, docks and pontoons, while providing unique boating design adaptations such as novel seating with specialty padding, efficient communication mechanisms, visual enhancements, transfer assistance, and manageable controls.<sup>33</sup> The sip-and-puff mechanism has been shown to be an effective and easy to learn control system that may be employed to allow for higher level injuries to participate with other sailors on equal terms. Those with a

higher-level complete injury must also consider the need for performing pressure relief maneuvers, assessing thermoregulatory difficulties, possible fatigue secondary to deconditioning, bladder and bowel dysregulation, and close monitoring for autonomic dysreflexia.<sup>14</sup> As the complications of higher level SCI may be encountered during active participation in any sport regardless of the nature, sailors face the added hazards of seafaring. The harm that may result from the added danger of being on water may be minimized by having a knowledgeable and well-trained support crew prepared for any situation.

During the course of ongoing assessment, rehabilitation is applied and redesigned to meet patients' needs, capabilities and aspirations as they arise. Rehabilitation is the process of development of patients to their highest physical, psychological, educational, social, and vocational potential by eliminating any biochemical pathophysiology, anatomic impairment, activity limitation, or barrier to participation.<sup>34</sup> The patient is adapted to traverse and master environments of choice (Figs. 2 and 3 - Concentric Sectors of the Environment). Rehabilitation interventions can be designed with consideration of the environments that concentrically surround the patient and application of the equipment and training necessary for mastery. The equipment if properly adapted to each unique case will act as a catalyst, facilitating the reaction between the patient and the sector of the environment where goals are met.

While conventional therapies remain the foundation of the neurorestorative process, growing evidence indicates marked physical and psychological benefits with activity-based therapy, aerobic exercise, functional recreation, in addition to land and aquatic-based sport.<sup>8,9,12,22</sup> One key in the advancement of aquatic sport and a major contributor to its growth was the inauguration of adaptive sailing at the Summer Paralympic Games in the year 2000 after initial demonstration in 1996. Bodies such as the International Association for Disabled Sailing, a branch of the International Sailing Federation, have further advanced the sport by creating functional classifications to allow for individuals with a broad range of disabilities to compete on equal terms. The collective effort of inspired communities to develop regattas and events affords disabled individuals the benefit of participating in sport on a recreational level while simultaneously engaging them in competition, providing social interaction, feelings of community reintegration and enhanced self-worth.<sup>28</sup> As sailing communities continue to foster a tradition characterized by an emphasis on education and instruction, the use of on-land sailing simulators have become

increasingly fundamental in promoting competence and mitigating the transition from land to water-based instruction.<sup>28</sup> These training experiences have provided greater ease of access and facilitated entry into the sport for several individuals, many of whom initially may have considered sailing particularly exclusive and intimidating.

In spite of continued growth of the sport in the general population, little published research on adaptive sailing, provides only limited anecdotal evidence in identifying its potential as a valid rehabilitation tool. Previous writings have identified the improvements seen in self-esteem and general well-being, although study sizes remain small and data mostly observational.<sup>35,36</sup> Recent work by Carta *et al.* highlighting the sport's rehabilitation potential in the treatment of individuals with mental health disorders provides insight into the psychosocial advantages sailing may uniquely offer in combatting the burden of emotional distress faced after SCI.<sup>37,38</sup>

Depression, anxiety and decreased self-esteem remain quite burdensome after injury, and have been shown to persist in both the acute and more chronic stages of paralysis.<sup>20,39</sup> Greater understanding of the emotional impact of SCI has secured more focus on the concept of psychological rehabilitation. In this unique approach, there is the commonly realized hope that participants go on to develop more supportive relationships by interacting with other similarly-challenged individuals, while at the same time creating a more robust sense of self. The novelty of sip-and-puff adapted sailing invigorates disabled sailors by putting them in full control of their boats, bringing them into the natural environment, pulled through the water by the wind yet providing challenges of navigation responding to unpredictable gusts. The thrill of independently guiding the boat in dynamic wind and wave conditions enlivens the operator with a personal sense of locus of control and provides an experience of independence. Unfortunately, the impact of such an emotionally charged experience may not be reflected adequately in generic rehabilitation outcome measures.

The challenging, unpredictable and lively environment on-water sailing provides stimulates coping and character-building strategies that produce resilience. Driven by many internal mechanisms, the process of resilience requires incremental positive adjustments necessary to circumvent barriers.<sup>40</sup> Often, rehabilitation focuses on physical deficits and distracts from the recognition of the value of building structured coping and confidence-building techniques to prevent the psychologically damaging effects an injury may produce over

time. A majority of individuals report resilience after SCI. Indeed there are positive correlations between resilience and self-efficacy, while those with less resilient thoughts and behaviors are more inclined to report feelings of distress.<sup>40,41</sup> Individuals who participate in sports after SCI have also noted its significant contribution in developing and maintaining resilience after injury. Participation in sport seems to address the need for social interaction, social support, and earning achievements, while simultaneously and uniquely providing translational confidence, emotional venting and competitive perseverance. Interestingly, a negative correlation between resilience and locus of control has been identified as a possible contributing factor.<sup>42</sup>

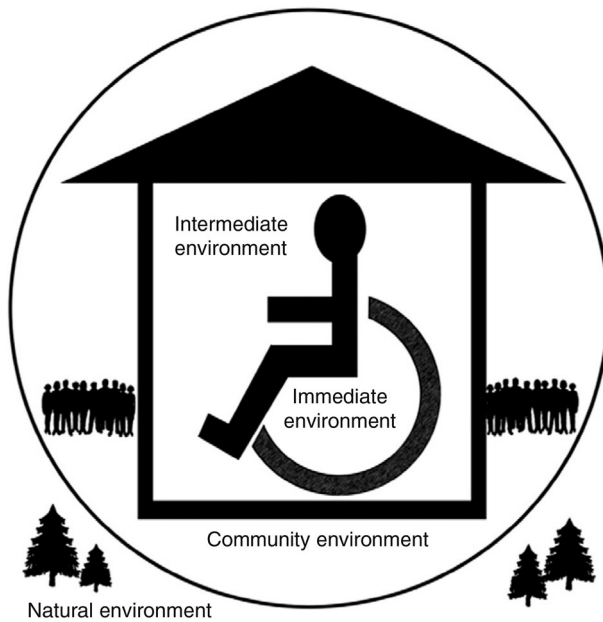
Locus of control is a theoretical construct developed by a psychologist Julian Rotter that is an assessment of the extent individuals believe they can control events that affect them internally. An external locus of control is the belief that uncontrollable outside processes have a greater influence on a person's internal mechanisms or outcomes. After SCI, greater externalization of health locus of control relating to injury and subsequent life events paralleled less resilient personalities. Previous studies have reported that individuals after SCI who maintain greater internalization of health locus of control report decreased perceptions of pain and increased general well-being.<sup>40</sup> Sailing may provide the patient with the experience needed to gain resilience and decrease the externalization of locus of control. Additional relationships have been described between locus of control and SCI post-traumatic stress disorder (PTSD). Developing a greater internal locus of control has been tied to coping with PTSD after injury and is associated with improvements in general health and well-being. PTSD in SCI has been well documented, with newer studies indicating up to 44% of the injured population possibly being affected.<sup>43</sup> Often refractory to treatment, PTSD, as well as general psychosocial stressors, causes significant distress and remains a substantial burden after injury.

With a greater focus on personalization of rehabilitation treatment, novel approaches are often warranted in addressing emotional hardship and assisting in development of healthy injury management strategies. Although lasting paralysis is a hallmark for many living with SCI, it has been argued that the complex emotional distress associated with an irreversible injury may have the greatest impact on quality of life.<sup>44</sup> As one of the major cognitive disruptors after injury, PTSD after SCI leads to greater feelings of helplessness and decreased self-esteem. Additionally, individuals with PTSD have been described as resistant to treatment due to poor

engagement, decreased motivation, increased anger, mood, avoidance, as well as physical and emotional pain imparted by injury.<sup>43,45</sup> The therapeutic application of sailing in the cognitive rehabilitation of individuals living with SCI stems from the larger concept of outdoor experiential education, combining the unique experiential absorption by the individual whilst instilling a sense of adventure. This idea fostered the creation of programs such as Outward Bound, one of the foremost leaders in providing experiential education. In providing an interactive learning experience in a natural environment, sailing as adventure and experiential education is not so much about the skills learned (e.g. navigation on water), but more so understanding deeper connections the experience offers. By overcoming adversity and conquering uncertainty, the gained ability to internalize and reflect on such experiences allows for the means to apply the skillset to future tasks. Similar therapeutic concepts have been applied to assist in the treatment of cognitive changes associated with chronic disease, cancer, traumatic brain injury and mental illness.<sup>46,49</sup>

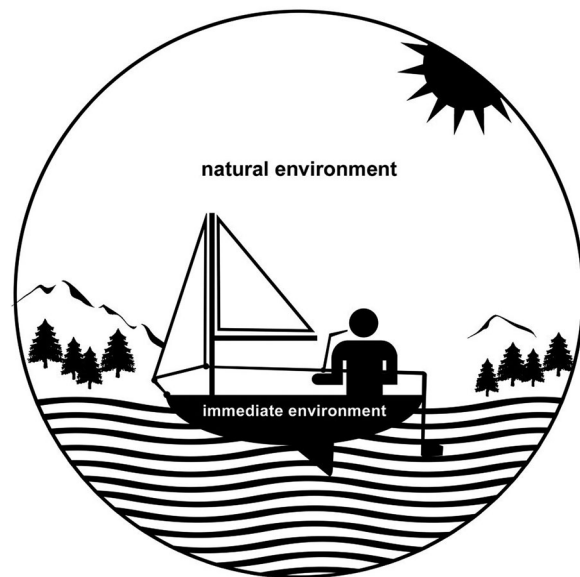
In this case, the participant was successful in navigating the bay using sip-and-puff controls. The loss of

independence after higher level injuries often translates to a loss of control over the natural environment.<sup>51</sup> By forfeiting a wheelchair (Fig. 2) and commanding a boat (Fig. 3), sailing allowed the participant to gain a sense of control he had not previously experienced through sport or nature. He explained that “the fact that I had my independence back for the time being was a great feeling”. Sense of control has been defined as a critical part of coping with an illness and allows those involved to take on a more active role, rather than remaining passive or reactionary.<sup>38,40,42</sup> With the use of adaptive equipment, the experience allowed him to engage peers and family members alike on relatively equal terms. Equally important was the feeling of being a participant and not just a spectator, or a patient undergoing a therapy session. Social interaction and the constant exchange of information between sailors provided the participant with quality recreation time and greater feelings of community involvement and integration. To the participant, the experience was real and meaningful, and he was active in reflecting upon his thoughts and emotions from his time on water in order facilitate further growth and motivation. It has helped bridge much of his own future



**Figure 2 Environmental adaptations for land access.**

Legend: For the purposes of planning rehabilitation interventions the environment can be divided into a series of concentric sectors. The **Immediate Environment** is in direct contact with the patients and travels with them. The **Intermediate Environment** is the space the patients occupy that can be adapted specifically for their function. The **Community Environment** is the space shared by all that should be accessible by design and as built as defined by laws. The **Natural Environment** includes the areas that are not adapted and accessed with specialized surfaces or adaptive equipment in the immediate environment for mobility.



**Figure 3 Environmental adaptations for water access with accessible sailboat.**

Legend: The adapted sailboat becomes the immediate environment because it interfaces directly with the patients and transmits them through the water under their control. Specific adaptations include a padded cockpit, two sip and puff controls to tend the jib sail and the tiller. The main sail is on a boom high enough that it swings over the head of the sailor. The surrounding natural environment has the sun, wind, rain and water based barriers the need to be addressed with a sail plan.

**Table 1 Sailing Resources provides a list of useful websites for sailors of any skill level, with or without interests in adaptive sailing, and additionally multiple forums highlighting sailing events, regattas, instruction and competitions. The table includes a link to an adaptive sailing resource manual made available free of charge**

Resource	Website
The Downtown Sailing Center – Baltimore's Community Sailing Center	<a href="http://www.downtownsailing.org/">http://www.downtownsailing.org/</a>
Paralympic Sailing	<a href="http://www.paralympic.org/sailing">http://www.paralympic.org/sailing</a>
National Disabled Sailing Program	<a href="http://www.sailtoprevail.org/">http://www.sailtoprevail.org/</a>
United States Sailing Association	<a href="http://www.ussailing.org/">http://www.ussailing.org/</a>
International Sailing Federation	<a href="http://www.sailing.org">http://www.sailing.org</a>
Sailing Leadership Forum	<a href="http://sailingleadership.org/">http://sailingleadership.org/</a>
Canada's International Regatta for Disabled Sailors	<a href="http://www.mobilitycup.org/">http://www.mobilitycup.org/</a>
The National Standard for Quality Sailing Instruction in Cooperation with the International Association for Disabled Sailing – Adaptive Sailing Resource Manual	<a href="http://www.ussailing.org/wpcontent/uploads/daroot/Adaptive%20Sailing/Adaptive%20Sailing%20Resource%20Manual.pdf">http://www.ussailing.org/wpcontent/uploads/daroot/Adaptive%20Sailing/Adaptive%20Sailing%20Resource%20Manual.pdf</a>

rehabilitative plans, as his own rehabilitation program has grown to include his desire to further participate in the sport of volleyball to pursue coaching and participating in wheelchair rugby. Therapy programs blending the concepts of adventure and nature may serve to overcome the physical and mental barriers often faced during the neurobehavioral treatment in SCI.

Although the outcomes experienced in this case reflect the journey of single, motivated individual, many working pieces enabled the participant to sail. Accordingly, the conclusions drawn and elaborated upon reflect the optimal situation afforded to a single participant. In reality, this required the efforts of family, friends and professionals in order to coordinate a successful sailing program. Future studies are required to investigate the costs, man-power, feasibility and development of an adaptive sailing program as it pertains to a particular region. However, a similarly motivated individual may find the chance to participate in a sailing program in his or her own community, as the significant growth of the sport has led to the creation of over 150 adaptive sailing programs in the United States alone.<sup>50</sup> Table 1 highlights several particularly useful resources for the adaptive sailor seeking further information regarding the sport. As organized competitive sailing is offered, further excitement with competition sustains interest and involvement with these activities.

### Conclusions: sailing club-rehabilitation team partnership

Pneumatically driven, multiple channel switches have been safely used for power wheelchair and computer controls for years and are familiar interfaces for many with upper cervical tetraplegia. Nonetheless, the medical literature on adaptive sailing is sparse. This case demonstrates how interdisciplinary collaboration, a motivated patient with good social support, and an

advanced community based sailing facility can offer rare opportunities. Independent sailing for people with high tetraplegia can potentially improve: mobility, mood, social role function, control over injury, feelings of depression, community reintegration, resilience, and access to natural environments.<sup>51</sup>

Collaboration between community sailing clubs and rehabilitation centers will increase the accessibility of boats and services as well as design unique solutions for patients that have specialized needs. These projects establish sustained community-based recreation accessibility through immersion and mainstreaming into existing heterogeneous institutions. This approach to rehabilitation may provide added benefit to traditional community programs. Rehabilitation units need to establish partnerships with institutions in the area to facilitate bridging patients to the community. Additionally, Recreation therapists are essential and should be maintained by all rehabilitation programs in order to help patients progress from inpatient to outpatient rehabilitation programs. Programs should utilize, partner with, and support institutions that catalyze the creation of adaptations for activity.

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