VITAGLIDE - LETTER OF MEDICAL NECESSITY FOR ALEXANDRA INGERSOLL

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1. Executive Summary

I am requesting the approval of the VitaGlide, an adaptive rowing rehabilitation machine, for my patient, Alexandra Ingersoll, by Blue Cross and Blue Shield of North Carolina (BCBSNC). The VitaGlide will provide Alexandra with a host of medical, mental, and physical benefits. Additionally, the VitaGlide will help her to reduce the burden of care and medical costs associated with physical deconditioning due to a sedentary lifestyle in a wheelchair. More importantly, the use of the VitaGlide will result in improved independence, assisted daily living activities (ADL's), self-care management, and the health, safety, and welfare for Alexandra.

Alexandra is a 38-year-old female with a diagnosis of a C6 (the level at which her spinal cord injury occurred) tetraplegia (also known as quadriplegia - paralysis caused by illness or injury that results in partial or total loss of use of all four limbs and torso) as a result of a diving accident on August 21, 2010. Alexandra does have functional use of her upper body including shoulder function, elbow function, wrist extension, and forearm function. However, proprioception is absent below the C6 level bilaterally meaning that she lacks full motor function and sensation below her nipple line. Prior to her injury, Alexandra was an active individual.

As a result of Alexandra's spinal cord injury, she suffers from urinary tract infections, spasticity, recurrent pressure sores, low HDL-C, chronic nerve pain, musculoskeletal pain, osteoporosis, and reduced respiratory function, among other complications discussed below. Alexandra is able to mitigate many of these secondary complications common to spinal cord injury as a result of a regimented home fitness therapy program and nutrition. Maintaining Alexandra's physical health results in her increased independence, improved Assisted Daily Living Activities (ADL's), reduction of costly secondary complications, and most importantly, improves her quality of life.

Since the time of her injury, Alexandra has pursued various therapy avenues to provide opportunities for strengthening and improving function for both the lower and upper extremities. For example, Alexandra utilizes a standing frame weekly as a weight-bearing exercise and to improve flexibility; Functional Electrical Stimulation (FES) bike for lower extremity, approved by Blue Cross and Blue Shield in 2016, three times a week; wrist weights for resistance training four times a week; range of motion exercises five days a week; and rigorous cardiovascular exercise four times a week with the use of her now broken VitaGlide.

The VitaGlide is suitable for in-home use and is determined by Alexandra's medical professionals to be the best system for her cardiovascular health. Alexandra has been using the VitaGlide with an excellent response over the last 10 years. Alexandra's current VitaGlide is broken and she has no alternative mode of cardiovascular exercise in her home. The VitaGlide, which Ali has successfully used in the past, delivers aerobic exercise through a biomechanically-favorable movement pattern that is best suited for patients with SCI, reducing the very real secondary complications of over use shoulder injuries that lead to debilitating reductions of ADL's, quality of life, and independence.

The VitaGlide, in my professional medical opinion, is medically necessary for Alexandra to maintain her physical condition and to minimize concomitant medical complications that have serious health consequences, and can be costly to resolve. Research in over ***130 peer-reviewed and established journals*** outlined below has demonstrated that the use of regular physical exercise for people living a sedentary lifestyle from spinal cord injury resulting in deconditioning, is medically necessary for the reduction of Cardiometabolic Diseases (CMD) and related secondary complications including, but not limited to: dyslipidemia, glucose intolerance, low High Density Lipoprotein (HDL-C), pressure sores, obesity, reduce peripheral vascular function, diabetes, low-grade chronic inflammation, bone and joint diseases, and musculoskeletal pain.

Benefits of regular cardiovascular health can only be reached by a frequency of at least three times a week as a long-term goal according to the recent "PVA Guidelines," which have established exercise as a primary management strategy for cardiometabolic diseases in individuals with SCI, setting the foundation for standard of care for patients who are physically deconditioned.

This is why it is essential for Alexandra to receive the VitaGlide for in-home use. Alexandra's caregiver schedule does not allow travel to a gym and local gyms do not have accessible equipment. Alexandra is able to use the VitaGlide without the assistance of a caregiver.

Good medical practice requires suitable patients be prescribed the VitaGlide and medically necessary pieces of equipment to protect their health by preventing secondary complications that would otherwise inevitably arise as a result of spinal cord injury and immobility.

The plan's process to include a committee or other formal body that reviews new technology should be employed. This committee's review and consideration of the enclosed reviews of relevant scientific information to augment their own research of articles in peer-reviewed literature, recommendations from professional societies, and summaries from organizations that rely on the judgment of experts when determining the effectiveness of this new technology is greatly appreciated.

The exclusion of general physical fitness equipment in the BCBSNC policy states that physical fitness equipment is a convenience item. However, as described in the evidence below, adapted physical fitness equipment for individuals with SCI is the recommended medical treatment to prevent and treat Cardiometabolic Diseases. Profound immobility following neurologic injury and disabilities is a unique and specialized situation requiring specialized solutions on the part of the patient and insurance companies working together; and should be evaluated on a case-by-case basis. We are not asking BCBS to create a blanket policy allowing all physical exercise equipment for individuals to be approved, but special exceptions to have the case reviewed under "medical necessity" need to be made in specialized cases such as Alexandra's.

In conclusion, as I will discuss in detail below, the VitaGlide adaptive rowing rehabilitation machine will provide Alexandra with a host of medical, physical, and functional benefits, which I, and her medical professionals, consider to be medically necessary.

2. <u>Peer-Reviewed Research Introduction</u>

Spinal Cord Injury (SCI) affects between 250,000 to 363,000 individuals in North America, with approximately 17,730 new SCI injuries per annum. The lifetime health cost of an individual with a cervical level injury is estimated to be between \$2 - \$4 million dollars with an average yearly cost of nearly \$120,000. Much of this cost is related to the treatment of preventable secondary complications arising from physical deconditioning due to a sedentary lifestyle (1).

Generally, persons with SCI experience accelerated risk for accumulating adipose tissue (2–15), developing lipid (16–25) and glucose (5,16,26–38) metabolism disorders. The accumulation of these "component risk factors" results in a condition known as Cardiometabolic Disease (CMD) (39–53). In addition, secondary complications associated with individuals with SCI include chronic low-grade inflammation, chronic pressure ulcers, urinary tract infections, amputations, respiratory problems, infections, increased spasticity, osteoporosis, skeletal muscle atrophy, and neuropathic pain.

The spinal cord community was first made aware of these risks in the early 1980's. Since then, hundreds of scholarly articles have examined antidotes, causes, personal and population characteristics, comorbidities, and treatments for these hazards. These studies have confirmed that persons with SCI are frequently sedentary, overweight, and at an elevated risk for developing CMD and its accompanying risk components. The prevalence of CMD reported in adults with SCI ranges from 31% to 72%, and often exceeds, the CMD prevalence for the general population (39).

Decline in muscle strength, endurance, and functional capacity in individuals with SCI as a result of a sedentary lifestyle has not only been linked to a decrease in quality of life, but to the main risk factors associated with the development of metabolic and cardiovascular disorders (54).

SCI results in progressive physical deconditioning due to limited mobility and lack of modalities to allow safe physical activity that may partially offset these detrimental physical changes.

Therefore, it is necessary to offer therapeutic activities, exercise programs, and sports modalities to individuals suffering from SCI in order to promote their participation in regular physical exercise programs to mitigate CMD, and accompanying risk components.

2.1 The Medical Consequences of Physical Deconditioning from a Sedentary Lifestyle

Not only is physical deconditioning strongly associated with the incidence of Cardiometabolic Disease (CMD) and the accompanying risk components, but also a host of well-established secondary complications.

CMD & Component Risks

The American Heart Association's (AHA) constituent CMD hazards, which are all considered risk components for CMD, include (39):

- Obesity (39,55–58)
- Insulin Resistance (39,55–58)
- Hypertension (39,56–59)
- Dyslipidemia (Low hi – density lipoprotein (HDL-C) and elevated triglycerides (TG)) (39,55–61)

CMD is a coalescing and interrelated cardiovascular, renal, metabolic, pro-thrombotic, and inflammatory health hazards; and is recognized as a disease entity by the American Society of Endocrinology, the American Heart Association (AHA), the International Diabetes Federation (IDF), the American Diabetes Association (ADA), and the World Health Organization (WHO) (39). The AHA and the National Institutes of Health (NIH) and National Heart Lung Blood Institute (NHLBI) define CMD as a coherence of any of these three medical hazards as described in the table below (39).

Guideline Definition of Cardiometabolic Disease		
Authority	**Diagnosis**	
AHA/NHLBI [3,12]	Three or more of:	Waist Circumference:* • Men — greater than 40 inches (102 cm) • Women — greater than 35 inches (88 cm)
		Plasma TG: ≥ 150 mg/dL (1.7 mmol/L)
		Reduced HDL ("good") cholesterol: • Men — Less than 40 mg/dL (1.03 mmol/L) • Women — Less than 50 mg/dL (1.29 mmol/L)
		Elevated blood pressure: ≥ 130/85 mm Hg or use of medication for hypertension
		Fasting glucose ≥100 mg/dL (5.6 mmol/L) or use of medication for hyperglycemia

*Note: Use of waist circumference is not validated in persons with SCI. Substitute definitions of obesity using: a: >22% BF body fat when using 3- or 4- compartment modeling, or b) BMI ≥ 22 kg/m^2.

CMD is recognized to increase the probability of developing atherosclerotic disease, heart failure, and diabetes. Prevalence in the US is estimated at 34% of the non-disabled adult population and is increasing with the population aging (39).

CMD is ultimately caused or worsened by a mismatch between energy consumption that is excessive in intake of kilocalories and saturated fats, and insufficient daily energy expenditure, making persons with SCI a high risk target for the disorder (39). These risks are typically expressed through lifestyle factors reflecting poor compliance with optimal nutrition and an active lifestyle (39). The primary metabolic abnormality of CMD is insulin resistance, while unified cause ensues excess body mass, whole clinical feature is excessive visceral and ecotopic fat (39). Inflammatory stress and endocrinopathies are not included in the AHA guideline risk, although both are recognized as either cause or consequence of the disorder (39).

Secondary Complications

- Type II Diabetes and related endocrine disorders (39,56–61)
- Excessive caloric and fat intake respect to energy needs (39)
- Elevated blood-born inflammatory markers (39)
- Arteriosclerosis (narrowing or and hardening of arteries) (39,56,58,59)
- Glucose intolerance and decreased insulin sensitivity (39,56,58,59)
    - Abnormal glucose homeostasis is associated with worsening lipid lipoprotein profiles resulting in the risk for development of hypertension and type II diabetes (56).
- Decubitus pressure ulcers (60)
- Chronic pain (60)
- Chronic inflammation (60)
    - Chronic inflammation is well known to be associated with a myriad of disorders including type II diabetes and all cardiovascular diseases (60).
    - Systematic inflammation impacts all body systems, not just one. Chronic low-grade inflammation is an established risk factor for metabolic disorders (60).

- <u>Bone and Joint Diseases </u>(58)
- <u>Immune Dysfunction </u>(58)
- <u>Body Composition</u> (58)
- <u>Decrease in vascular density </u>(58,61)

The devastating effects of physical deconditioning on the body as a result of a sedentary lifestyle increases a patient's risk for CMD and related secondary complications. These life-threatening and preventable complications severely reduce the patient's quality of life and increase lengthy hospital stays due to secondary complications. Through proper nutrition and physical activity, CMD and risk components have the potential to be greatly reduced over the patient's life.

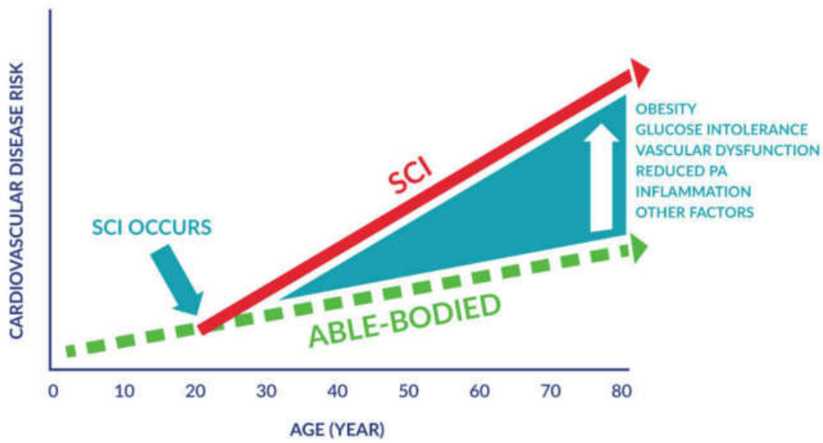
2.2. Cardio Metabolic Diseases and Secondary Complications Accompanying SCI

Persons with SCI face unique health challenges throughout their lives as a result of being physically deconditioned from a sedentary lifestyle. They are among the most physically deconditioned of all humans (62) and, not surprisingly, experience accelerated pathological states and conditions normally associated with physical deconditioning and premature aging; CMD; dyslipidemia and heart disease; arterial circulation insufficiency and clotting disorders; bone and joint diseases; osteoporosis; body composition changes; and pain of musculoskeletal and neuropathic origins (39,54,59).

Additionally, a consequence of physical inactivity, body composition alterations, and metabolic disturbances in individuals with SCI are predisposed to excessive abdominal obesity, and consequently low-grade systemic chronic inflammation, which is a well-established risk factor for cardiometabolic disorders (58,61,63).

Asymptomatic Cardio Vascular Disease (CVD) also occurs at early ages after SCI and its symptoms may be vast by the interruption of ascending afferent pain fibers conveying warnings of impending heart damage or death (59).

Taken together, the SCI population has a higher increased risk of osteoporosis, CVD, obesity, respiratory problems, muscle spasticity, and contractures compared to the general population (64). Thus, the increased risk of comorbidity secondary to injury is greatly elevated.



The prevalence of CMD reported in adults with Spinal Cord Injury (SCI) ranges from 31-72% (39). The prevalence of these medical conditions escalates with aging. This leads to life-threatening conditions, extensive economic burden, poor quality of life, and shorter lifespan among those with SCI (65).

CMD and Component Risks

In the aforementioned section, the AHA constituent hazards of CMD include:

- Obesity (39,55–58)
- Insulin Resistance (39,55–58)
- Hypertension (39,55–57,59)
- Dyslipidemia (Low hi – density lipoprotein (HDL-C) and elevated triglycerides (TG)) (39,55–59,61,66)

Risk Factor	Literature Support
• Abnormal lipoprotein profiles	(Brenes et al. 1986, Dearwater et al. 1986, Bauman et al. 1992b, Krum et al. 1992, Maki et al. 1995, Dallmeijer et al. 1997, Bauman et al. 1998, Bauman et al. 1999a, Bauman et al. 1999b)
• Abnormal glucose homeostasis	(Myllynen et al. 1987, Bauman and Spungen 2001)
• Increased relative adiposity, elevated body fat and/or reduced lean body mass	(Bauman et al. 1999c, Spungen et al. 2003)
• Reduced peripheral vascular function and/or arterial	(Wecht et al. 2000, Hopman et al. 2002, Wecht et al. 2003, de Groot et al. 2005, Zbogar et al. 2008, Wong et

Risk Factor	Literature Support
compliance	al. 2012, Phillips et al. 2012)
• Increased risk for deep vein thrombosis	(Miranda and Hassouna 2000)
• Abnormal haemostatic and inflammatory markers	(Vaidyanathan et al. 1998, Kahn 1999, Roussi et al. 1999, Kahn et al. 2001, Frost et al. 2005, Lee et al. 2005b)
• Excessive homocysteine (an amino acid)	(Bauman et al. 2001)
• Depressed endogenous anabolic hormone levels (e.g. serum testosterone and growth hormone)	(Claus-Walker and Halstead 1982b, Bauman and Spungen 2000)
• Increased activation of the renin-angiotensin-aldosterone system (a hormone system that regulates blood-pressure and fluid balance).	(Claus-Walker and Halstead 1982a)
• Hypertension	(Lee et al. 2005a)
• Reduced aerobic fitness	(Hoffman 1986)

These risk components are the same if not greater for people with SCI (56).

CMD and Component Risks Accompanying SCI

The hazards of CMD and the associated risks accompanying SCI include:

<u>Obesity</u> (2–15,39,47,54,56–58,63–65,67–70)

- Obesity (excessive adiposity) is a major risk component for CMD after SCI (39).
- Obesity after SCI is associated with risks of insulin resistance, diabetes, dyslipidemia, and hypertension (39).
- Obesity in persons with SCI's are grossly underestimated when using both a surrogate marker of Body Mass Index (BMI) and criterion scores for obesity typically used in the general population (39).
- Body composition - increased fat loss of lean muscle mass after SCI contribute to the developing of secondary complications of chronic disease (60).
- Evidence suggests that there is a 22% - 40% decline in the basal metabolic rate (BMR) in persons with SCI (65).
- Obesity risks increase in patients with SCI due to a hyper caloric diet, lack of physical activity, and reduction in metabolic rate (65).
- Generally persons with SCI experience accelerated risk for accumulating adipose tissue (2–15).

Insulin Resistance (39,47,48,54–56,58–60,65,67,69)

- The risk of insulin resistance, diabetes or CMD in persons with SCI is at least as great as persons without SCI (39).

- Glucose Intolerance - abnormal glucose homeostasis is associated with worsening lipid lipoprotein profiles risk for the development of hypertension and type II diabetes (56,67).

- Insulin resistance occurring in a higher percentage of persons with SCI was first reported more than two decades ago. Since that time, others have confirmed this finding and included insulin resistance among the cardiovascular risks sustained by persons aging with SCI. Almost half of people with SCI live in a state of carbohydrate intolerance or insulin resistance (59).

- Evidence suggests approximately 50 to 75% of persons with SCI suffer from impaired glucose intolerance or type II diabetes mellitus (65).

- Persons with SCI generally experience accelerated risk for developing glucose metabolism disorders (5,16,26–38).

Hypertension (39,47,54–56,58,59,69,70)

Dyslipidemia (Low hi – density lipoprotein (HDL-C) and elevated triglycerides (TG)) (39,47,54–56,58,59,61,67,69,70)

- The prevalence dyslipidemia among persons with SCI is high when based on established cholesterol guidelines and when compared to nondisabled individuals (39).

- The most consistent component of dyslipidemia risk among persons with SCI, when compared to nondisabled individuals, is depressed levels of HDL-C (39).

- Persons with SCI generally experience accelerated risk for developing lipid metabolism disorders (16–25).

While physical deconditioning per se is not included among the five component risks of CMD, it is linked with and considered a major cause of obesity, insulin resistance, hypertension, and dyslipidemia (67). Several factors, however, point to physical conditioning after SCI as a major contributor to CMD diagnoses:

1. SCI population was long ago identified at the lowest and the human fitness continuum, making physical deconditioning suspect as a cause for CMD related risks (22,71,72).

2. A common finding after SCI is a low concentration of HDL-C (25,73,74), which is known to persons without disability to be cardio productive and strongly linked with low levels of cardiorespiratory fitness (75–77).

3. Barriers to exercise participation are altogether common after SCI and may include self-imposed obstacles to exercise participation or legitimate physical barriers to exercise, lack of adaptive exercise equipment, limited professional assistance, and financial limitations (78–81).

Additional Secondary Complications Associated with a Sedentary Lifestyle in SCI

As physical deconditioning is a common consequence for most SCI's, it can further exacerbate the impact of injury and lead to the increased risk of chronic secondary complications. It has been suggested that much of the excess in early morbidity and mortality within the chronic SCI population is caused by inactivity related illnesses and secondary complications (68), all of which greatly impact quality of life and the health, safety, and welfare of the patient. The tragedy in this for the SCI population is that many of these secondary complications are preventable with access to the correct specialized equipment.

Cardiometabolic diseases, including CVD, is of the most common causes of death in people with chronic SCI. CVD is the leading cause of death in individuals with SCI over the age of 60 or 30 years after injury (68).

The following section addresses the supplementary hazards associated with SCI that are population risk-relevant to CMD, but not included among the AHA risk component hazards of CMD.

- **Arteriosclerosis & Heart Failure** (55,56,59,67,68,82)
    - Various authors have demonstrated reduced peripheral vascular function and/or arterial compliance (56).
    - Arterial circulatory insufficiency (82–85).
    - For those with tetraplegia, a chronic reduction of cardiac preload and myocardial volume coupled with pressure under loading causes the left ventricle to atrophy (59).
- **Inflammation** (39,61,63)
    - Chronic inflammation after SCI results and worsens secondary complications that applies the risk of cardiometabolic disorders after injury, directly impacting the quality of life and mortality risk after SCI (61).
    - Chronic inflammation is now known to be associated with a myriad of disorders including type II diabetes and all cardiovascular diseases (61).
    - Severe immunosuppression leads to systematic inflammation and weakened immunity (64).
- **Chronic Pressure Ulcers** (64,70,86)
    - Due to a sedentary lifestyle pressure ulcers are a common and expensive complication following SCI. Prevalence for persons with chronic SCI varies between 15 and 30%. Relieving pressure and skin monitoring are the most to prevalent preventative strategies that have been established (87,88).
    - Pressure ulcers have become the second cause of re-hospitalization after SCI, with estimated annual costs ranging between 9.1-$11.6 billion per year in the US. Cost of individual patient ranges from $20,900-$151,700 per pressure ulcer. Medicare estimated in 2007 that each pressure ulcer added $43,180 in costs to a hospital stay (88)

- **Diabetes** (16,33,39,47,51,55–57,59,68–70,89,90)

    - Type II diabetes mellitus occurred at a heightened frequency and earlier in the lifespan in individuals with SCI compared to able-bodied individuals (68).

  - Evidence suggests approximately 50 to 75% of persons with SCI suffer from impaired glucose intolerance or type II diabetes mellitus (65).

  - It's important to recognize that the prevalence of diabetes exceeds 50% in persons with SCI (65).

- **Urinary Tract Infections (UTI)** (70)
  - UTI's remain the most frequent infection in patients with SCI and occur at a rate of 2.5 events per patient per year due to a neurogenic bladder, which promotes bacterial colonization and impairs the phagocytic ability of epithelial cells that line the urinary bladder (91).

- **Amputations** (65,86)
  - The prevalence of amputation exceeds 30% in persons with SCI (65), which leads to longer hospitalizations, chronic infections, and long-term chronic pain.

- **Respiratory Problems** (64,92)
  - Respiratory complications are associated with reduced physical fitness and increased cardiovascular morbidity individuals with tetraplegia (92).

- **Infections** (64,86)
  - Systematic infections are a direct result of immobility (64).

- **Increased Spasticity** (64,70)
  - Spasticity is often experienced by individuals with SCI following a period of spinal shock, and, in many cases, the symptoms negatively affect quality of life and activities of Daily Living (ADL), inhibiting effect of self-care, causing pain, fatigue, disturbing sleep, compromising safety, contributing to the development of contractures, pressure ulcers, and infections (93).

  - Spasticity is a motor disorder characterized by a velocity-dependent increase in tonic structure reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper excitability of the stretch reflex. The literature has shown that 65 to 78% of sample populations of individuals with chronic SCI suffer from specificity (93).

- **Osteoporosis** (47,54,56,60,64,68,86)
  - Bone mineral density decreases rapidly after SCI as a result of neural, vascular, and hormonal changes, thus increasing risk of osteoporosis and fractures (60).

  - Rapid bone demineralization after the first year of SCI, which continues to slowly decay.
    - Most studies of sub-lesional muscle after SCI in humans report fibers that:
      - Are smaller than those above the lesion and those persons without SCI, have less contractile protein, produce lower peak contractile forces, transformed towards fast

    - phenotypic protein expression, increase myosin heavy chain isoforms, and decrease their resistance to fatigue (59).

- **Skeletal Muscle Atrophy** (54,57,59,64,65,92)
    - Due to a sedentary lifestyle skeletal muscle atrophy decline in lean mass are key features after SCI. Within a few weeks post SCI, there's more than 40% loss in skeletal muscle size and lower extremity. This process of continuous loss of muscle mass is magnified by the aging process. The rapid loss of muscle mass in SCI leads to serious metabolic consequences similar to extensive decline in basal metabolic rate, insulin resistance, and impaired glucose intolerance (65).

- **Pain of musculoskeletal and neuropathic origins** (61,82,92,94–98)
    - It's widely known individuals SCI suffer from long-term chronic neuropathic pain, which results in further physical deconditioning due to the lack of accessibility of physical activity equipment.
    - Further, regular ADL's including wheelchair propulsion and transferring in bed lead to upper extremity overuse injuries causing chronic long-term pain for individuals with SCI.

Ultimately, SCI increases morbidity and mortality associated with cardiometabolic diseases, secondary to increases in central adiposity, hyperlipidemia, and impaired glucose intolerance (67). Many of these risk factors associated with CMD can be reduced with long-term physical activity, and nutrition.

2.3 Physical Activity has Extensive Therapeutic Benefits of Physical Activity for Individuals with SCI

A sedentary lifestyle either imposed or adopted by persons with Spinal Cord Injury (SCI) has long identified physical inactivity as a population health risk (39).

Reduction of fitness after SCI is attributable to various factors including inactivity imposed by diminished active muscle contraction; the need for special equipment and assistance performing exercise; physical and financial barriers; and pain and injury (39).

The SCI population is at an even greater risk for chronic diseases because the physical inactivity and subsequent muscle atrophy associated with an SCI result in less total lean body mass, less regional lean body mass, and increased percentage of fat than an able-bodied person (57).

Engagement in routine physical exercise and activity is known to improve fitness (66,99–102), reduce the risk of developing CMD component and non-component conditions, and diminish pathogenicity of CMD component risks severity after diagnoses (39,47,55,56,58,60,63–65,67,69,70,102–104).

A growing body of evidence has been comprehensively reviewed in a number of scholarly monograms, which quickly supports the beneficial effect of exercise (40,52,58,66,82,105–108).

<u>There is strong and consistent evidence that exercise after SCI:</u>

- **Reduces risk of CMD & Accompanying Risk Components** (39,55,56,58,63–65,67–70,103,104) including: Obesity, insulin resistance, hypertension, dyslipidemia.

- **Reduces Body Mass Index (BMI)** (57,60,67)
  - People living with chronic SCI who engage in at least 25 minutes a day of mild to moderate intensity Leisure Time Physical Activity (LTPA) have a lower BMI and percentage Fat Mass (FM) (57).

  - Pulmonary evidence indicates exercise and sports participation results in greater lean mass among the SCI population (60).

  - Increased fat mass and loss of lean mass after SCI contribute to the development of secondary complications of chronic disease and can be significantly reduced through consistent physical exercise (60).

- **Improves Lipid Profiles** (39,56,60,103,104)
  - Evidence suggests that lipid profiles in persons with SCI respond favorably to both diet and exercise intervention (56).

  - Exercise is effective at reducing lipid lipoprotein profiles involved in the formulation of atherosclerosis in the reduction of the risk for Cardio Vascular Disease (CVD) in persons with SCI (56).

  - The use of arm ergometry or circuit resistance training can increase HDL in the range of 10 to 20% and reduce the ratio of total cholesterol to HDL (106).

  - Pulmonary evidence indicates exercise and sports participation results in higher HDL-C among the SCI population (60).

  - SCI individuals engaging in circuit exercise resistance training experienced a Total Cholesterol (TC)/High density Lipoprotein (HDL-C) decline from a high risk score of 5 to the desired score of 3.5 (103).
    - These findings support the beneficial effects of circuit exercise resistance training on fitness and atherogenic lipid profiles in persons with chronic paraplegia (103).

- **Reduces Insulin resistance and Improves Insulin Sensitivity (Decreased risk of Diabetes)** (39,55,56,58,60,104)
  - Higher levels of exercise were associated with lower risk for insulin resistance (56).

  - It is well established that habitual physical activity is an effective primary preventative strategy against insulin resistance and type II diabetes in the general population (56).

  - Effects of exercise training on glucose metabolism in the SCI population found improvements in glucose homeostasis, which may be a result of increased lean body mass and increased expression of GLUT-4, glycogen, synthase, and hexokinase and exercise muscles (56).

Effects of Exercise Training on Glucose Metabolism in Persons with Spinal Cord Injury

Author, Year; Country Score Research Design Sample Size	Methods	Outcomes
de Groot et al. 2003; Netherlands PEDro = 7 RCT Level 1 N = 6	**Population:** 4 male, 2 female, C5-L1, AIS A (*n* = 1), B (*n* = 1), and C (*n* = 4), age 36 yrs, 116 d post-injury. **Treatment:** Randomized to low-intensity (50%–60% HRR) or high-intensity (70%–80% HRR) arm ergometry, 20 min/d, 3 d/wk, 8 wks. **Outcome Measures:** VO_2peak, insulin sensitivity, blood glucose.	1. There was a significant difference in insulin sensitivity between groups, with a non-significant decline in the high-intensity group and a significant improvement in the low-intensity group with training. 2. A positive correlation between VO_2peak and insulin sensitivity (r = 0.68, p = 0.02).
Jeon et al. 2010; Canada Pre-post Level 4 N = 6	**Population:** 6 male participants with paraplegia participated in the study (mean age, 48.6 ± 6.0 y; mean weight, 70.1 ± 3.3 kg; injury levels between T4-5 and T10). **Treatment:** 12 weeks of FES-rowing exercise training 3 to 4 times a week (600–800 kcal). **Outcome measures:** VO_2peak, plasma leptin, insulin, and glucose levels, insulin sensitivity, body composition.	1. VO_2peak increased from 21.4 ± 1.2 to 23.1 ± 0.8 $mL \cdot kg^{-1} \cdot min^{-1}$ (P = 0.048). 2. Plasma leptin levels were significantly decreased after the training (pre: 6.91 ± 1.82 $ng \cdot dL^{-1}$ vs. post: 4.72 ± 1.04 $ng \cdot dL^{-1}$; P = 0.046). 3. Plasma glucose and leptin levels were significantly decreased after exercise training by 10% and 28% (P = 0.028), respectively. 4. Plasma glucose, Leptin levels and Whole body fat decreased but did not reach statistical significance.
Mahoney et al. 2005; USA Pre-post Level 4 N = 5	**Population:** 5 males, complete SCI, C5-T10, AIS grade A, age 35.6 yrs, 13.4 yrs post-injury. **Treatment:** Home-based neuromuscular electric stimulation-induced resistance exercise training, 2 d/wk, 12 wks. **Outcome Measures:** quadriceps femoris muscle cross-sectional area, plasma glucose, insulin.	1. All participants had normal fasting glucose levels before and after training. 2. There were no significant changes in blood glucose or insulin with training. However, there was a trend towards reduced plasma glucose levels (p = 0.074).
Phillips et al. 2004; Canada Pre-post Level 4 N = 9	**Population:** 8 male, 1 female, incomplete AIS C, C4-T12, 8.1 yrs post-injury. **Treatment:** Body-weight–supported treadmill walking, 3 d/wk, 6 months. **Outcome Measures:** whole-body dual-energy X-ray absorptiometry (to capture body composition and bone density), GLUT4 protein abundance, hexokinase activity, oral glucose tolerance tests, glucose oxidation, CO_2 breath analysis.	1. Reduction in the area under the curve for glucose (-15%) and insulin (-33%). 2. The oxidation of exogenous (ingested) glucose and endogenous (liver) glucose increased (68% and 36.8%, respectively) after training. 3. Training resulted in increased muscle glycogen, GLUT-4 content (glucose transporter) (126%), and hexokinase II enzyme activity (49%).
Jeon et al. 2002; Canada Pre-post Level 4 N = 7	**Population:** 5 male, 2 female, motor complete, C5-T10, ages 30-53 yrs, 3–40 yrs post-injury. **Treatment:** FES leg-cycle training, 30 min/d, 3 d/wk, 8 wks. **Outcome Measures:** oral glucose tolerance test (OGTT), glucose and insulin levels, glucose utilization, insulin sensitivity and levels.	1. There were significantly lower (14.3%) 2-hr OGTT glucose levels after 8 wk of training. 2. Glucose utilization was higher for all 3 participants and insulin sensitivity was higher for 2 of the 3 participants during posttraining 2-hr clamp test.
Mohr et al. 2001; Denmark Pre-post Level 4 N = 10	**Population:** 8 male, 2 female, 6 tetraplegia, 4 paraplegia, C6-T4, age 35 yrs, 12 yrs post-injury. **Treatment:** FES cycling, 30 min/d, 3 d/wk, 12 months; 7 participants completed an additional 6 months (1 d/wk). **Outcome Measures:** insulin-stimulated glucose uptake, oral glucose tolerance test (OGTT), GLUT 4 glucose transporter protein.	1. Insulin-stimulated glucose uptake rates increased after intensive training. 2. With the reduction in training, insulin sensitivity decreased to a similar level as before training. GLUT-4 increased by 105% after intense training and decreased again with the training reduction. The participants had impaired glucose tolerance before and after training, and neither glucose tolerance nor insulin responses to OGTT were significantly altered by training.
Chilibeck et al. 1999; Canada Pre-post Level 4 N = 5	**Population:** 4 male, 1 female, motor complete C5-T8, ages 31–50 yrs, 3–25 yrs post-injury. **Treatment:** FES leg-cycle ergometry training, 30 min/d, 3 d/wk, 8 wks. **Outcome Measures:** glucose transporters (GLUT-4, GLUT-1), oral glucose tolerance test, citrate synthase.	1. Training resulted in increases in GLUT-1 (52%) and GLUT-4 (72%). 2. There was a training-induced increase in citrate synthase activity (56%) and an improvement in the insulin sensitivity index as determined from oral glucose tolerance test.
Hjeltnes et al. 1998; Sweden Pre-post Level 4 N = 5	**Population:** 5 males, C5-C7, all complete AIS A, age 35 yrs, 10 yrs post-injury. **Treatment:** Electrically stimulated leg cycling exercise, 7 d/wk, 8 wks. **Outcome Measures:** peripheral insulin sensitivity, whole body glucose utilization, glucose transport, phosphofructokinase, citrate synthase, hexokinase, glycogen synthase, blood glucose, plasma insulin.	1. After training, insulin-mediated glucose disposal was increased by 33%. There was a 2.1-fold increase in insulin-stimulated glucose transport. 2. Training led to marked increases in protein expression of GLUT4 (glucose transporter) (378%), glycogen synthase (526%), and hexokinase II (204%) in the vastus lateralis muscle. 3. Hexokinase II activity increased 25% after training.

- Pulmonary evidence indicates exercise and sports participation results in greater insulin sensitivity among the SCI population (60).

- Early studies in SCI/D report subjects with diabetes having significantly higher average glucose-stimulated plasma insulin levels than those individuals with normal glucose tolerance, suggesting a common state of insulin resistance (33,109).

  - This risk has been attributed to post-injury changes in body composition as well as reduced levels of exercise and non-exercise physical activity. A cross-sectional study of persons with SCI/D reported an association between low activity levels and higher fasting glucose (44), while a similar study found that 23% more physically inactive individuals than active people with SCI/D were classified as insulin resistant (57,58).

- It is well documented that exercise can reduce insulin resistance and improve insulin sensitivity (110–112). A recent cross-sectional study examining glucose homeostasis in physically active and non-active individuals with chronic SCI/D reported significantly lower fasting plasma insulin and homeostasis model assessment of insulin resistance (HOMA-IR) values in persons undertaking regular physical activity (113).

  - Upper extremity interval training programs also appear to be an effective method for improving insulin sensitivity, (114,115) with a recent study (116) reporting 37% and 40% reductions in fasting insulin and HOMA-IR levels, respectively, after a 6-week indoor hand-cycle exercise program (58).

- **Reduces Shoulder Pain** (58,89,100)
  - Upper limb pain is the most common symptom of physical dysfunction reported by SCI. A large segment of the paralyzed population lives in pain in the shoulders and arms with reports of 35 to 73% of people with chronic paraplegia (100).

    - Upper limb pain must be prevented if function is to be enhanced by exercise.

    - As many as half of people with SCI experience significant shoulder pain intensified by wheelchair propulsion and body transfers, which are activities critical to quality of life and health maintenance. Exercises focusing on posterior shoulder and upper back appear to lessen the pain (100).

- **Improves Cardio Respiratory Fitness & Muscle Strength** (60,64,67,70,99,103,104)
  - Cardiovascular improvements include cardiac hypertrophy, maximal work rate, maximal consumption, maximal lactate rate, and pulmonary function in athletes with SCI as compared to sedentary individuals with similar injuries (60).

  - Results of graded arm exercise testing showed a 30.3% improvement in peak oxygen consumption, a 33% increase in time to fatigue, and a 30.4% increase in peak power output. This change reflects a cardiovascular risk reduction of almost 25% (103).

- Drawing from the results of 22 exercise training studies - there is strong evidence of muscular strength can be significantly improved with a variety of exercise training modalities including circuit resistance training, arm ergometer, and Functional Electrical Stimulation (FES) assisted exercise (60).

- Due to SCI individuals experiencing loss of muscle mass due to denervation and inactivity, the importance of muscle strength cannot be overstated. Moreover, because muscle mass is metabolically active, if changes in muscle strength are accompanied by changes in muscle mass, such increases could positively affect metabolism (60).

- **Exercise for Bone Health** (117–120)
    - A recent systematic analysis identified 11 exercise-intervention studies that aim to determine the effect of non-FES exercise on bond health in persons with SCI. Unfortunately, the primary type of exercise examined in the studies involved some type of lower-extremity loadbearing (such as locomotor training, standing, etc.). However, three studies examine the effect of general exercise on bone health in SCI. One longitudinal study showed that, in the first 12 months post injury, habitual physical activity was positively associated with bone mineral density (117). A cross-sectional study examined the association of daily physical activity and bone health in SCI should physical activity benefits bone density and bone -related hormones in adult men with cervical spinal injury (119).

      Finally, elite wheelchair basketball players were shown to have higher arm bone density, but not lumbar spine bone density (118). The findings with the wheelchair basketball players (118) highlight an important consideration regarding bone assessments in SCI. The lumbar spine is a common scan site for assessing bone health in the general population and the spine was previously the most common scan site in SCI. However, of all the skeletal sites the lumbar spine is consistently shown to be the most preserved in SCI (120), with other sites in the lower extremities being most impaired. The International Society of Clinical Densitometry (ISCD) recently put forth SCI-specific bone assessment guidelines (120), but these guidelines have been available only for a short amount of time. Therefore, the aforementioned studies that assess the lumbar spine could have overlooked the beneficial effects of physical activity on the health of the bones that are the most impaired by SCI.

- **Exercise for Bowel/Bladder in SCI**
    - Unfortunately, very little research has been conducted on the effect of exercise training bowel and bladder function in persons with SCI. However, recent studies have shown that locomotor-rehabilitation (121) and other multimodal exercise programs (122) improve self-reported bowel and bladder function.

- **Reduces Chronic Inflammation** (63)
    - Individuals with SCI engaging in an arm crank exercise program showed improved low-grade systemic inflammation by decreasing plasma level of inflammatory cytokines (63).

        - Several studies have reported that cytokine research is relevant to multiple aspects of SCI care such as CVD, type II diabetes, metabolic syndrome, and sepsis. Further, it has also been suggested exercise intensity is important in the regulation of inflammatory molecules (63).

    - In fact, maximal exercise (incremental bicycle tests until exhaustion) induced an inflammatory response characterized by leukocytosis and increased inflammatory cytokine levels (IL – six, matrix metalloprotease-9, myeloperoxidase (63).

- **Decreases Neuropathic Pain and Spasticity** (123,124)

- **Improves Assisted Daily Living Activities (ADL's)** (58,60,104)
  - ADL'S decreased physical capacity is associated with an increase in secondary health complications as well as a decrease in function and ability to perform ADL's such as self-care activities, work activities, and household chores. A growing body of literature points to physical capacity as a key factor in determining independence in individuals with SCI/D (58,125–128).

- **Quality of Life** (64,68,70,89,104)
  - A six-week upper body exercise intervention in individuals with SCI improved their health related quality of life (HRQOL) (89).

- **Chronic Pressure Ulcers** (86)

Exercise is a cornerstone that can ameliorate many of the aforementioned CMD & accompanying risks in addition to secondary complications arising from physical deconditioning due to a sedentary lifestyle for individuals living with SCI. Evidence clearly supports a therapeutic role of physical activity after SCI as an effective countermeasure to these risks.

2.4 Therapeutic Benefits of Aerobic & Resistance Training in SCI

Due to individuals with SCI experiencing loss of muscle mass due to denervation and inactivity, extensive evidence documents the effectiveness of all training modes to improve cardiopulmonary conditioning (58).

Evidence also indicates performing aerobic exercise regularly improves the cardiometabolic risk profile with respect to Body Mass (BMI), total daily energy expenditure, lipid profile, and glucose homeostasis among others (59).

Cardiovascular research conducted within the field of SCI has predominantly examined the effects of aerobic exercise and/or Functional Electrical Stimulation (FES) training. Given the motor loss of lower limbs following injury, upper extremity exercise is a logical choice for improving cardiovascular fitness and health (56).

Upper Extremity Training on Cardiovascular Fitness & Associated Secondary Improvements in individuals with SCI

Improvement in physical fitness in people who have been physically deconditioned due to a sedentary lifestyle is now well-established to mitigate CMD and the component risk factors in addition to reducing a host of costly and deadly long-term secondary complications.

Specifically, upper extremity training in individuals with SCI has been shown to:

- **Increase High Density Lipoprotein (HDL-C)** (56,65,100,104)

- Lowered HDL-C is normally associated with and is likely a direct result of a sedentary lifestyle (103) as cross-sectional studies in individuals with SCI/D observe an association between low peak aerobic capacities and low HDL-C (44), and also consistently find less atherogenic lipid profiles in those who are habitually highly active or physically fit (129).

- An interventional study investigating the effects of moderate intensity (70%-80% of maximum HRR) over an 8 week training program performed 20 minutes daily and 3x/week reported increases in HDL-C and decreases in TG, LDL-C, and TC, HDL-C ratio(136); the latter a proxy for global cardiovascular disease risk (58).

- The use of arm ergometry or circuit resistance training can increase HDL in the range of 10% to 20% to reduce the ratio of total cholesterol to HDL (56).

- **Improve Glucose Homeostasis** (56,65,67,104)
  - Evidence found in cardiovascular research that both aerobic and FES training are effective in improving glucose homeostasis in persons with SCI (56).

  - Improved fasting insulin (2)
    - 16 weeks of upper body Circuit Resistance Interval Training (CRIT) was shown to enhance fasting markers of hepatic insulin sensitivity (67).

- **Improve Cardiorespiratory Fitness (CRF)** (56,58–60,63,67,70,92,104,110,130)

  - ***Aerobic Capacity*** (56,58–60,63,67,70,92,104,130)
    - Individuals with SCI experienced a 20% to 30% improvement; however, it is not uncommon for improvements to exceed 50% after having been evaluated for moderate to rigorous intensity exercise. These studies used arm ergometry, wheelchair ergometry, and swimming-based interventions (56).

    - There are 2 exercise benefits for which there is extremely strong and consistent evidence -- improved CRF and improved muscular strength. Evidence indicates that Cardio Respiratory Fitness (CRF) of both tetraplegia (TP) and paraplegia (PP) improves in response to upper limb aerobic training or circuit training.

      - In a review of 14 exercise training studies, VO2 peak improved by 11.2% and peak oxygen improved by 15.6%. Clinically significant changes in the strength of non-paralyzed muscle groups can be achieved through exercise resistance training and circuit training (104).

  - ***Improve Peak VO2 (VO2 peak), Peak Workload (PW) & Peak Power Output (PPO peak)*** (56,58,60,63,70,92,130)
    - VO2 peak & PO peak have proven to be valid and sensitive outcome measures for assessment of physical capacity in individuals with SCI. Extensive evidence documents the effectiveness of all training modes to improve cardiopulmonary conditioning (58).

Average VO_{peak} and PO_{peak} in individuals with paraplegia, tetraplegia, and age-matched nondisabled individuals[115,150]

	PP		TP		ND	
	M	F	M	F	M	F
Test modality	Arm ergometry		Arm ergometry		Treadmill	
Age, years	36.0 ± 9.0	33.6 ± 10.2	35.0 ± 10.3	40.0 ± 7.0	30-39	30-49
VO_{2peak}, mL/kg/min	16.5	13.21	8.71	9.37	42.4	34.3
PO_{peak}, W/kg	0.92	0.71	0.20	0.19	NA	NA

Note: Distribution of participants was PP, *n* = 109; TP, *n* = 68; American Spinal Injury Association Impairment Scale A, *n* = 42; AIS B, *n* = 17; AIS C, *n* = 3; AIS D, *n* = 1. PP and TP age values are given as mean ± *SD*; ND age values are given as range. F = female; M = male; ND = nondisabled; PO_{peak} = relative peak power output; PP = paraplegia; TP = tetraplegia; VO_{2peak} = relative peak oxygen consumption.

- Upper extremity exercise including arm crank ergometer, wheelchair, and swimming have all shown to improve VO2 peak in those with SCI. The studies report an increase of 10% to 20% following 8 to 12 weeks of training (generally 3x-5x/week of 20 to 60 minutes in duration, and intensity of 50% to 80%) (130).

- A study measuring VO2 max and PPO peak in tetraplegia patients during hand cycling showed gains of 23.8% NPO peak and 99% in VO2 peak (70).

○ ***Increase in sub maximal stroke volume and cardiac output*** (56)

○ ***Progressive increase in Muscle strength*** (56,60,73)

- Drawing on the results of 22 exercise training studies (60) concluded that there is strong evidence that muscular strength can be significantly improved with a variety of exercise training modalities including circuit resistance training, arm ergometer, and FES assisted exercise.
    - The importance of muscle strength cannot be overstated because muscle mass is metabolically active; if changes in muscle strength are accompanied by changes in muscle mass, such increases could positively affect metabolism (60).

- Circuit Resistance Training (CRT) and multiple resistance activities for short periods of interposed endurance exercise improved muscle strength, endurance, anaerobic power, and shoulder pain (130).

- **Decreased BMI & Waist circumference** (56,63,104)
    - A study done by ACRM investigating the effects of arm cranking exercise in individuals with SCI showed waist circumference and anthropometric index diminished (63).

- **Improve Assisted Daily Living Activities (ADL's) & Quality of Life** (57,60,64,68)

Exercise training positively influences cardiorespiratory function, cardiometabolic risk profile, strength, BMI, lipid lipoprotein profiles, and glucose homeostasis (104). Perhaps most importantly, cardiovascular fitness allows individuals with SCI to improve ADL's in order to live their lives more independently, improve quality of life, reduce the need secondary care, and costly secondary complications.

2.5 SCI Exercise Recommendations

The Consortium for Spinal Cord Medicine (CSCM) recently released Clinical Practice Guidelines for CMD in persons with SCI (59). These authoritative guidelines are known as the "Paralyzed Veterans of America (PVA) Guidelines" and are the first clinical practice guidelines outlining diagnosis, and management of CMD in persons with SCI.

The PVA Guidelines show that persons with SCI have a 2 to 3-fold increased risk for obesity, 2-fold increased risk for diabetes, a unique profile of dyslipidemia characterized by low high-density lipoprotein cholesterol (HDL-C), and unique blood pressure considerations in those with injuries above T7 who experience autonomic dysreflexia. As well as surveillance methods for CMD risk factors, the PVA Guidelines also set forth management strategies.

<u>Physical exercise is recommenced as a primary treatment strategy for the management of CMD in SCI. The PVA Guidelines are the first to put into policy exercise as a medical management strategy for CMD in SCI.</u>

PVA Physical Activity Recommendation for persons with SCI

Individuals with SCI should participate in at least 150 minutes of physical exercise per week, according to their ability, beginning as soon as possible following acute spinal cord injury. The 150 minutes per week guideline can be satisfied by sessions of 30 to 60 minutes performed 3 to 5 days per week, or by exercising at least 3, 10 minute sessions per day. When individuals with SCI are not able to meet these guidelines, they should engage in regular physical activity according to their abilities and should avoid inactivity (39).

However, these guidelines are not the only support for exercise for CMD management in SCI, and other scientific evidence supports exercise strategies:

Canada's "SCI Action Canada" Initiative

> SCI Action Canada recently updated their evidence-based activity guidelines (30) to conclude, with moderate to high confidence, that exercise benefits CMD in persons with SCI (131).

Exercise and Sport Science Australia (ESSA)

> Australia's lead exercise organization, ESSA, also recently released a position statement on exercise in SCI endorsing emerging evidence for the benefit of exercise CMD in SCI (104).

World Health Organization (WHO)

The WHO's guidelines on physical activity have now been updated to recommend exercise for all persons, including those who have chronic physical disability and specifically stating that exercise benefits the cardiovascular co-morbidities of SCI (104).

Furthermore, numerous systematic-review papers (39,56,57,59,60,64,65,68,69,104,131) have corroborated the beneficial effects of exercise on CMD in SCI put forth by the aforementioned policy-driven and authoritative guidelines. These guidelines recommend a minimum of:

- 20 to 30 minutes of aerobic exercise 3-5 times per week
- Strength training at least two times a week with three sets of 8 to 10 reps per set

Combined, the evidence for the beneficial effects of exercise on CMD in SCI is overwhelming.

2.6 Physical Activity, and the VitaGlide in Particular, Benefits Individuals with SCI, and will reduce BCBS' Coverage Costs in This Case

SCI is a traumatic, life disrupting event and is characterized by progressive physical deconditioning due to limited mobility and lack of modalities to allow safe physical activity that may partially offset these deleterious physical changes.

Collectively, about 363,000 patients with SCI, or 65% of the entire spinal cord injury population in the United States, engages in insufficient physical activity representing a target population that could derive considerable health benefits from even modest physical activity levels (64).

Currently, the annual direct costs related to SCI exceed $45 billion in the US. Rehabilitation protocols and technologies aimed to improve functional mobility have the potential to significantly reduce the risk of medical complications and costs associated with SCI (64).

Cost Benefit of Physical Activity

- Rehabilitation protocols and technologies aimed to improve functional mobility have the potential to significantly reduce the risk of medical complications and cost associated with SCI. Following discharge from inpatient rehabilitation, physical activity levels dramatically decline (59) such that the great majority of patients remain sedentary for the remainder of life.

  However, patients who are able to participate in physical activity enjoy tremendous health benefits and health care cost savings. Patients who exercise at least twice per week have a 50% lower risk of hospitalization in the first year versus sedentary patients (132).

  Furthermore, for every 5-point increase in Functional Independence Measure (FIM) motor score, the number of hospitalizations each year is reduced by 0.022 and percentage of patients requiring assistive care decreases by 3.6% (133). Given that hospitalizations and assistive care represent almost 90% of the direct costs attributable to SCI (134), the potential cost benefits of improved motor function can be approximated.

- For every 5-point increase in FIM motor score, annual direct costs decrease by about US$25,000 in the first year and US$4,000 annually thereafter. Based on previous studies of outpatient physical activity programs, FIM motor score improvements of 5 to 20 points can be reasonably expected with chronic exercise (135,136).

  Therefore, in a patient who commences routine physical activity in the first post-injury year and given a FIM motor score improvement of 10 to 15 points, cumulative direct cost savings would total US$81,000 to US$122,000 at 5 years and US$290,000 to US$435,000 over a lifetime, primarily due to fewer hospitalizations and less reliance on assistive care,

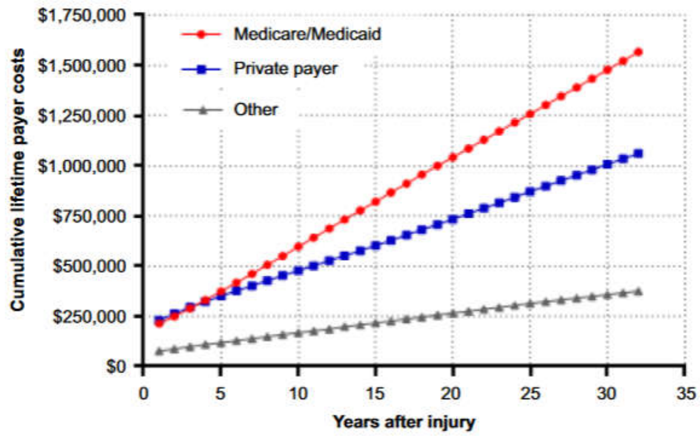


Figure 2 Cumulative lifetime primary payer costs in a typical spinal cord-injured patient in the US.
Notes: Model assumes 32-year survival after spinal cord injury. Over a typical post-injury life span, cumulative primary payer costs will total US$3.0 million, with Medicare/Medicaid paying US$1.6 million (52%), private payers paying US$1.1 million (35%), and others (e.g. worker's compensation, Veteran's Administration) paying US$400,000 (13%) of medical costs.

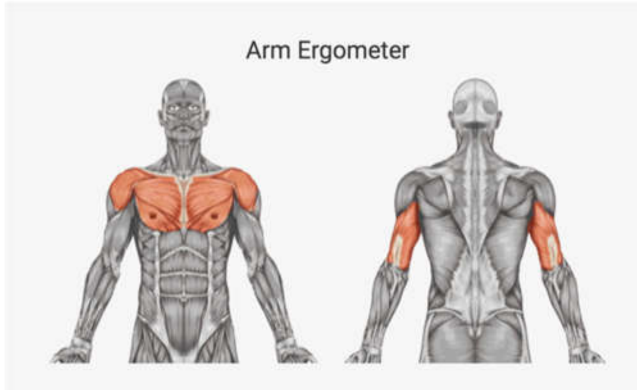
2.7 The VitaGlide Results in Unique Benefits for Individuals with SCI

Progressively higher levels of spinal cord injury (SCI) cause greater loss of muscle mass in those muscles that serve as prime movers and stabilizers of the trunk. This requires that the arms simultaneously generate propulsive forces and a steady trunk during exercise (82).

Upper limb pain is the most common symptom of physical dysfunction reported by those with SCI, and shoulder pain the most common complaint. It is also the location for commonly experienced rotator cuff dysfunction, tears, and impingement. A large segment of the paralyzed population lives in pain in their shoulders and arms, and wrists with complaints reported in this 35% to 73% of people with chronic paraplegia (130).

Shoulder pain is often intensified by wheelchair propulsion and body transfers, which are activities critical to activity and health maintenance (130). The severity of upper limb pain increases during common transfer activities and increases as time after injury lengthens, although exercise focusing on the posterior shoulder and upper back appear to lessen the pain (130).

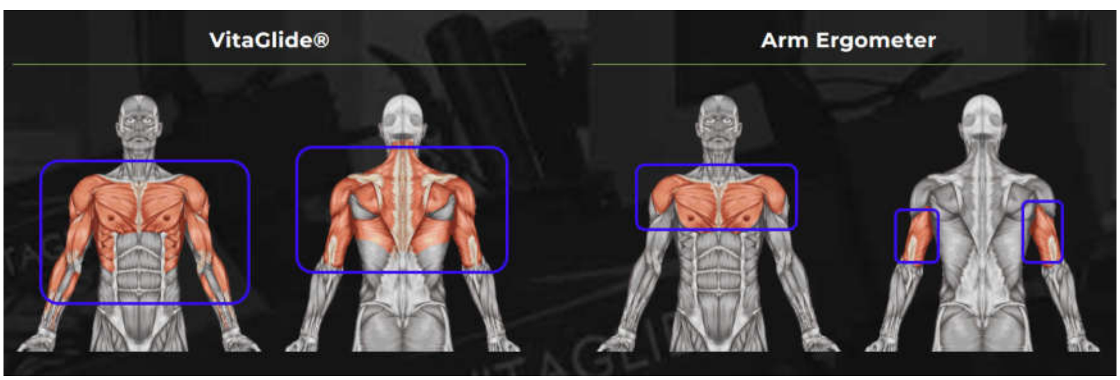
Others have examined effects of arm cycle ergometry and found that arm crank cycle exercise is a poor choice for use as a training mode for upper extremities strengthening because it fails to target the muscles most involved in the performance of daily activities (82). Arm crank ergometry utilizes the same muscles as wheelchair propulsion and body transfers.



Unfortunately, most of these arm exercise protocols failed to address the need for upper extremity strength training in the use repetitive contractions of shoulder muscles, which may hasten the pain and dysfunction of upper extremities (137). Moreover, it has previously been suggested that upper body exercise, primarily arm crank ergometry as a training modality, may contribute to shoulder overuse injuries and trigger the onset of pain (89).

VitaGlide as an Alternative Upper Extremity Aerobic Exercise Modality

The VitaGlide was developed and tested at the Miami Project by Neurosurgeon, Dr. Barth Green, a physical therapist and a Durable Medical Manufacturer. It was developed with intention to provide individuals with SCI an alternative modality for regular aerobic and resistance training in order to reduce the overuse injuries as a result of wheelchair propulsion, body transfers, and standard hand crank ergometer's.



The VitaGlide utilizes the core, oblique, back, and arm muscles in order to strengthen and reinforce orbit muscles to prevent shoulder impingement. This is an extremely for effective solution to keep the upper body muscles and core strength intact (www.vitaglide.com).

The VitaGlide allows for a natural fluid motion that creates no stress on the shoulders, which a serious long-term complication is for many individuals with SCI as discussed in the aforementioned sections above.

What makes the VitaGlide particularly unique is that patients have the ability to select independent resistances on each arm while engaging in aerobic cardiovascular exercise.

There are presently no other pieces of adaptive exercise equipment offered on the market and the VitaGlide is the sole provider, company, and manufacturer of this piece of equipment.

3. Outcome Measures Achieved with Aerobic Exercise for Alexandra

Alexandra has remained committed to her continued in-home exercise therapy over the last 10 years consisting of 3-5 days a week of aerobic, standing, Functional Electrical Stimulation (FES), range of motion, and resistance training. As a result of her regimented in-home rehabilitation program she's been able to maintain and continually improve muscle strength resulting in:

1. **Improved Independence & Assisted Daily Living Activities (ADL's)**

    ○ Mobility
    - Alexandra has the upper body strength to move herself from the bed to the chair and chair to the bed with minimal assistance from caregivers due to upper body strength.

    ○ Personal Hygiene
    - Alexandra is able to perform her own personal hygiene including brushing hair, minimal assistance with getting dressed, and brushing teeth.

    ○ Meal Preparation
    - Alexandra is able to prepare her own meals one place that a level height on the counter.

    ○ Reduction in Caregiver Hours
    - Alexandra can be left alone for a good portion of the day because she has the strength, coordination, confidence, and functional ability to take care of herself without fearing for her safety of falling or being able to reach what she needs to when left alone due to physical deconditioning.

2. **Improvements in range of motion**

3. **Bladder sensation and awareness resulting in decreased autonomic dysreflexia**

4. **Reduced incidence of decubitus pressure ulcers**
    a. A sedentary lifestyle often results in increased pressure ulcers due to lack of blood flow and movement.
    b. Alexandra has suffered Stage 4 pressure ulcers resulting in costly surgeries and long hospital stays.

5. **Improved blood circulation**
    - Through the use of regular exercise Alexandra experiences consistent and noticeable reduction in edema of the lower extremities.

6. **Weight Management**
    - Obesity is common within the SCI population and through proper diet and nutrition Alexandra is able to maintain a healthy weight in a wheelchair.

7. **Noticeable decrease in daily spasticity leading to a reduction in her baclofen dosage.**

8. **Reduction of chronic nerve pain**

9. **Reduced Shoulder Pain**
    - With the use of the VitaGlide, not the arm crank ergometer, which typically results in SCI patients developing long-term chronic shoulder pain, Alexandra has been able to reduce musculoskeletal upper extremity pain in her neck, and scapula.

    - Alexandra's current VitaGlide is broken and she has no alternative means for aerobic activity to address this issue and improve respiratory function.

Additional therapeutic benefits from a long-term regimented exercise program for Alexandra also results in:

1. **Reduction of Cardio Metabolic Disease (CMD) and associated risk components including, but not limited to:** dyslipidemia, glucose intolerance, obesity, and hypertension.

2. **Reduction in secondary complications including:** spasticity, nerve pain, autonomic dysreflexia, decubitus pressure ulcers, blood circulation, and respiratory illness including bronchitis and pneumonia.

The VitaGlide represents a lifelong commitment to protecting Alexandra's health, improving her quality of life, and avoiding expensive secondary complications resulting in costly long-term hospital stays.

Not Primarily for Convenience of Patient

A regimented exercise program for a spinal cord injury patient is not a volitional activity selected from a wide range of choices, nor is it an optional activity for Alexandra. This is not a convenience item. Profound immobility following neurologic injury and disabilities is a unique and specialized situation requiring special solutions.

Finally, I would like to point out that there is a critical difference between physical activity and exercise. Physical activity encompasses any movement of the body that produces contractions of the skeletal muscle and the resultant energy expenditure increases above an individual sedentary baseline. Exercise is a planned, structured program of activities geared directly toward achieving or maintaining physical fitness by focusing on a specific part of the body to improve its performance.

People with spinal cord injury are not afforded the same opportunity for physical exercise programs as the non-disabled population are due to equipment not being properly adapted.

4. The VitaGlide is Medically Necessary Durable Medical Equipment in This Case

In September of 2020 Alexandra was denied the VitaGlide with the rationale that it was not a covered benefit because it is physical exercise equipment, which BCBSNC stated was a convenience item despite the recommendations of myself and fellow medical professionals on her team.

Under section titled, "WHAT IS NOT COVERED?" it states in pertinent part, "This health benefit plan does not cover services, supplies, drugs or charges for:...
A benefit, drug, service or supply that is not specifically listed as covered in this benefit booklet...
Convenience items.....
The following equipment:
• Physical fitness equipment.....
• Standing frames.... ";

Under section titled, "GLOSSARY" it states in pertinent part, "DURABLE MEDICAL EQUIPMENT - Items designated by Blue Cross NC that can withstand repeated use, are used primarily to serve a medical purpose, are not useful to a person in the absence of illness, injury or disease, and are appropriate for use in the patient's home... ";

I'd like to address this ruling because, as dozens of peer-reviewed papers address in the above sections, a structured and rigorous physical exercise routine relates directly to preventing CMD and related risk components and SCI. The VitaGlide along with Alexandra's home exercise program reduces costly secondary complications. There is a very strong case for the VitaGlide to be classified as DME. Further, there is an even stronger case to be made for the VitaGlide the Medically Necessary DME.

The reduction in the secondary complications in addition to current secondary complications Alexandra mitigates as a result of her home exercise program designed by her physical therapist are far less costly to address now than waiting for her to develop diabetes, which is a very common consequence of living a sedentary lifestyle.

The VitaGlide costs around $3,200, but with chronic immobility and the development of diabetes, for example, please consider the potential long-term financial outlay a diabetic patient alone: monitoring strips, lancets, insulin and physician office visits. All of these items are for regulating, maintaining, and monitoring the disease; not for deferring and preventing or repairing disease. If she were to become a diabetic, the cost of the VitaGlide would be claimed by physicians, hospitals, pharmacies, laboratories, etc. within 6 to 9 months.

Thousands of dollars' worth of claims will be filed for years to come. The VitaGlide will help to mitigate the probability of these possible expenditures and those from likely secondary complications.

Under Alexandra's Benefit Book at for Blue Home with UNC Health Alliance Insurance plan, the definition of DME as defined by BCBSNC is as follows:

Description of Procedure or Service

Durable Medical Equipment (DME) is any equipment that provides therapeutic benefits to a patient in need because of certain medical conditions and/or illnesses.

Durable Medical Equipment (DME) consists of items which:

- are primarily and customarily used to serve a medical purpose;
- are not useful to a person in the absence of illness or injury;
- are ordered or prescribed by a physician;
- are reusable;
- can stand repeated use, and
- are appropriate for use in the home.

DME includes, but is not limited to, wheelchairs (manual and electric), hospital beds, traction equipment, canes, crutches, walkers, kidney machines, ventilators, oxygen, monitors, pressure mattresses, lifts, nebulizers, bili blankets and bili lights.

The VitaGlide meets every single definition of DME as defined by BCBSNC:

1. <u>Serve a medical purpose</u>

a. The VitaGlide serves to improve and has improved Alexandra's ADLs, improve muscle strength, blood circulation, reduces pressure sores, reduces spasticity, glucose intolerance, nerve pain, respiratory illnesses, and autonomic dysreflexia.

b. The VitaGlide also serves to reduce CMD and associated risk components including dyslipidemia, glucose intolerance, obesity, and hypertension with regimented physical activity.

2. Is useful to a person with an illness or injury
   - Alexandra sustained a C6 spinal cord injury in 2010

3. Is ordered by a physician
   - I, Dr. Holt, have ordered the VitaGlide as medically necessary DME

4. Is reusable
   - The VitaGlide is a long-term piece of physical exercise equipment

5. Can stand repeated use
   - The VitaGlide can be used repeatedly

6. Is appropriate for in-home use
   - The VitaGlide was designed for in-home use

The VitaGlide also meets the definition of Medically Necessary as defined by BCBS Corporate Policy:

Definition of Medical Necessity

The following criteria are the basis for the Plan's determination that a service is medically necessary.

1. The service is one that a physician, exercising prudent clinical judgment, would provide to a patient for the purpose of preventing, evaluating, diagnosing or treating an illness, injury or disease or its symptoms, and except for covered clinical trials (as described in policy, "Clinical Trial Services"), not for experimental, investigational or cosmetic purposes.

2. The service is in accordance with generally accepted standards of medical practice.

3. The service is clinically appropriate in terms of type, frequency, extent, site and duration; and considered effective for the patient's illness, injury or disease; and not primarily for the convenience of the patient, physician or other health care provider.

For these purposes, "generally accepted standards of medical practice" means standards that are based on credible scientific evidence published in peer-reviewed medical literature generally recognized by the relevant medical community, physician specialty society recommendations, and the views of physicians practicing in relevant clinical areas and any other relevant factors.

For medically necessary services, the Plan may compare the cost-effectiveness of alternative services or supplies when determining which of the services or supplies will be covered and in what setting medically necessary services are eligible for coverage.

The following rationale addresses each Medical Necessity point:

1. I, Dr. Holt, as Alexandra's prescribing physician in addition to Bryn Kennedy, Alexandra's spinal cord injury physical therapist, prescribed the VitaGlide to her for the purpose of preventing and treating her injury and secondary illnesses associated with spinal cord injury. The VitaGlide is not experimental, investigational, or for cosmetic purposes.

2. The VitaGlide is in accordance with the Generally Accepted Standards of Medical Practice; meaning that the VitaGlide justification is based on credible scientific evidence that has been published in peer-reviewed medical literature, and is generally recognized the relevant medical community as justified above in the scientific section of this paper.

3. The VitaGlide is considered clinically appropriate and effective for Alexandra's spinal cord injury and the prevention of CMD and related risk components. The VitaGlide is NOT primarily for the convenience of the patient, but medically necessary to maintain current health status in addition to preventing secondary complications arising from spinal cord injury, and a sedentary lifestyle

Further, BCBSNC states that the plan may compare the cost effectiveness of an alternative service or supplies when determining if the benefit is eligible for coverage. The VitaGlide company is a sole manufacturer of this piece of equipment, which specifically addresses, not only the therapeutic benefits of physical exercise, but addresses the very real challenge standard arm crank ergometer's neglect - overuse shoulder injuries.

5. What is Not Covered

In 2020 Alexandra and her medical professionals submitted a claim for the seat elevator function of her power wheelchair, which was denied by BCBSNC. BCBSNC stated the reason for denial was that the seat elevator is "an electric seat lift is considered an upgrade or convenience item." Therefore, the electric seat lift was not a covered benefit.

Explanation of Basis for Determination:

After review of additional clinical information, request for coverage of an electric seat lift remains denied.

Durable medical equipment (DME) is covered when:
--it does not serve primarily as a comfort or convenience item or
--it is not an upgrade beyond what is needed to meet your medical needs even though it may contribute to your independence or help your caretakers in transfers, moving in your wheelchair, or other routine movement

An electric seat lift is considered an upgrade or convenience item.

Please note: other codes for a power wheelchair have been approved.

Blue Cross NC Medical Policy: Durable Medical Equipment, Wheelchairs (Manual and Power Operated)

SANDRA NEWTON, MD
Medical Director
Healthcare Management and Operations

The appeals process was initiated and BCBCNC ultimately overturned their initial denial stating that the *"administrative decision is based on the individual merits of this specific case. This approval should not be considered a precedent for future or similar cases."*

In 2020 Alexandra and her medical professionals submitted another claim for the VitaGlide. The claim was also denied and the reason outlined by BCBSNC stated the VitaGlide was a convenience item and therefore not a covered benefit. Alexandra tried to submit for an appeal, but was denied for appeals right due to the VitaGlide not being a covered benefit.

Case Details:

Patient Name: Alexandra Ingersoll
Member ID: BFP10227230400
Appeal ID: 548972

Provider(s): Stalls Medical Inc.
Date(s) of Service: Future
Type of Service: Durable Medical Equipment - Vitaglide

Reason for Denial: Noncovered Benefit (Reference Number: 114959933, dates of service September 14, 2020 – March 13, 2021)

Alexandra was denied the opportunity to prove the medical necessity of the VitaGlide because it was a benefit not covered by her plan, but was afforded the opportunity to prove her case with the electric seat lift, which BCBSNC ultimately found to be an eligible benefit based on her specific case.

We are only looking for the same opportunity to prove the therapeutic benefit of the VitaGlide to BCBSNC on Alexandra's behalf. We've laid out a very strong case in the previous sections that the VitaGlide should not only be considered a piece of DME, but medically necessary as it relates specifically to Alexandra's medical condition.

6. Conclusion

Research clearly supports a global therapeutic benefit of cardiorespiratory exercise for individuals with SCI. Furthermore, there is a sufficient body of literature to draw evidence-based conclusions about the therapeutic benefit of cardiorespiratory exercise on specific diseases in persons with SCI.

Recently, evidence-based policy guidelines and scientific consensus has established that exercise is a treatment strategy for cardiometabolic disease and associated risk factors in SCI. Furthermore, emerging evidence suggests that exercise benefits a very long list of secondary complications in SCI, which lead to recurrent costly hospitalizations for the patient and insurance companies. Prevention of these secondary complications improve the life of individuals with SCI while simultaneously reducing costs for the healthcare system in the United States.

The recent “PVA Guidelines” have established exercise is a primary management strategy for cardiometabolic diseases in individuals with SCI, setting the foundation for standard of care for patients with SCI who are physically deconditioned as a result of paralysis and living a sedentary lifestyle. Paralysis causes inactivity and exacerbates deconditioning due to paralysis.

Adoption of exercise into the chronic care of SCI and maintenance of co-morbidities throughout the lifespan of individuals living with SCI places a special importance on identification of sustainable exercise practices. The VitaGlide delivers exercise through a biomechanically-favorable movement pattern best suited for patients with SCI, likely reducing the very real secondary complications of overuse shoulder injuries that lead to debilitating reduction of ADL's, quality of life, and independence.

The exclusion of general physical fitness equipment in the BCBSNC policy states that physical fitness equipment is a convenience item. However, as clearly laid in this case, adapted physical fitness equipment for individuals with SCI is certainly not a convenience, nor a luxury. Individuals with SCI do not have access to the proper medically necessary durable medical equipment in order to maintain their health, safety, and welfare of their functional muscles in order to carry out their activities of daily living.

As previously mentioned, profound immobility following neurologic injury and disabilities is a unique and specialized situation requiring specialized solutions on the part of the patient and insurance companies working together.

Therefore, it is my medical opinion the VitaGlide is not just a standard piece of physical exercise equipment, but one that is medically necessary DME according to BCBS's definition of medically necessary and DME under the company's Corporate Medical Policy.

In conclusion, we would like this request to be reviewed through a committee of specialists and to assess the request using the following:

- Formal mechanism in place for the plan to evaluate and address new developments in technology and new applications of existing technology for inclusion into the patient's benefit plan in order to keep pace with changes and to ensure that, Alexandra as a member, has equitable access to safe and effective care, and services.

Sincerely,

Kenneth, A. Holt

References

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