



**Jefferson** | Magee Rehabilitation

Regional Spinal Cord Injury Center of the Delaware Valley  
NIDRR-designated

# *Spinal Cord Injury Manual*

A publication of the  
Regional Spinal Cord Injury Center  
of the Delaware Valley

The Regional Spinal Cord Injury Center of the Delaware Valley provides a comprehensive program of patient care, community education, and research. It is a federally designated program of Thomas Jefferson University and its affiliated institutions of Thomas Jefferson University Hospital and Magee Rehabilitation Hospital.



# Spinal Cord Injury Patient-Family Teaching Manual

**A Publication of the  
Regional Spinal Cord Injury Center  
of the Delaware Valley**

Researched and prepared by the clinical  
personnel of Thomas Jefferson University  
Hospital and Magee Rehabilitation Hospital

Available online at:

[www.spinalcordcenter.org](http://www.spinalcordcenter.org)

© 1993, 2001, 2009 Thomas Jefferson University. This publication is the property of Thomas Jefferson University. All rights reserved. This Manual is intended for use in a total system of care that meets all applicable CARF standards for SCI Centers. Neither Thomas Jefferson University Hospital, nor Magee Rehabilitation Hospital is responsible for any liability, claims, demands or damages asserted to be the result, either directly or indirectly, of the information contained herein. The use or reprinting of any part of this manual requires the express permission of Thomas Jefferson University.



## Dedication

The Handbook Committee of the RSCICDV gratefully acknowledges the assistance and dedication of all who contributed to this manual, and all the others who worked so hard to make this Handbook a reality.

Lori Bennington, RN  
Amy Bratta, PT, DPT, NCS  
Sharon Caine, PT  
Catharine M. Farnan, RN, MS, CRRN, ONC  
Dawn Frederickson, BSN  
Karen Fried, RN, MSN, CRRN, CCM  
Colleen Johnson, PT, NCS  
Nicole Krafchek, PT  
Cynthia Kraft-Fine, RN, MSN  
Marlene Kutys, MSW  
Linda Lantieri, PT, ATP  
Frank Lindgren  
Mary Grace Mangine, OTR/L  
Dina Mastrogiovanni, OTR/L, ATP  
Vilma Mazziol, LPC  
John Moffa, RT  
Mary Patrick, RN (**Editor**)  
Evelyn Phillips, MS, RD, LDN, CDE  
Marie Protesto, RN  
Julie Rece, RN, MSN, CRRN, CWOCN  
Katheleen Reidy, PhD  
Jessica Rickard, CTRS  
Margaret Roos, PT, DPT, MS  
Susan Sakers Sammartino, BS  
Mary Schmidt Read, PT, DPT, MS (**Editor**)  
Patricia Thieringer, CTRS  
John Uveges, PhD  
Cheryl West, PT, DPT

This publication is supported in part by Thomas Jefferson University, a grant received from the National Institute on Disability and Rehabilitation Research (NIDRR), Office of Special Education and Rehabilitative Services (OSERS), U.S. Department of Education, Washington, D.C. and by the Geoffrey Lance Foundation.



# Cardiovascular

Introduction .....	1
Description of the Cardiovascular System .....	1
Identification of Normal Regulation of the Cardiovascular System .....	1
Description of Cardiovascular Compromise Experienced by People with Spinal Cord Impairment .....	2
Glossary .....	6
References .....	7



# Cardiovascular

## Introduction

Cardiovascular problems affect all people who have a spinal cord injury. It has been noted to be particularly problematic for those over 65 years old and those who have been injured for more than 30 years. Due to this problem affecting many people, it needs to be addressed early in your rehabilitation as well as throughout your life.

## Description of the Cardiovascular System

The cardiovascular system contains the heart and the blood vessels. The heart is a muscular pump in the chest that receives blood from blood vessels from all over the body. As the heart beats, it delivers blood to the lungs so that oxygen can be exchanged. This oxygenated blood is then given back to the heart and pumped to all the organs throughout the body. The blood vessels are the arteries, capillaries and veins that are located throughout the body. The blood vessels carry blood to all the tissues of the body and remove the tissues' waste products.

## Identification of Normal Regulation of the Cardiovascular System

The autonomic nervous system consists of two parts: the sympathetic nervous system and the parasympathetic nervous system. The sympathetic and parasympathetic work together to maintain the status quo in the body. The sympathetic nervous system is the one in charge of cardiovascular and respiratory systems. The parasympathetic is the one in charge of body functions like digestion, salivation, and urination.

The control center of the sympathetic nervous system is located in the thoracic levels of the spinal cord. The sympathetic nervous system is responsible for tightening or relaxing the blood vessels in response to blood pressure changes in the body. For example, if your blood pressure is too low (normal is about 120 / 80 depending on the person), the sympathetic nervous system will cause a constriction of the blood vessels so that blood pressure will return to normal. If your blood pressure is too high, the sympathetic nervous system will allow the blood vessels to widen and then blood pressure can be decreased.

If you have a spinal cord injury above the level of thoracic six (T6), then the sympathetic nervous system has been damaged and the normal activities that have been described above are not working as well. As the time since your injury increases, the body does figure out a way to maintain the health of your body.



## **Description of Cardiovascular Compromise Experienced by People with Spinal Cord Impairment**

The cardiovascular changes that occur after spinal cord impairment include orthostatic hypotension, autonomic dysreflexia and deep vein thrombosis. Heart muscle weakness also occurs as people with spinal cord impairment get older. The cardiovascular system plays a key part in these complications.

Orthostatic hypotension, or low blood pressure when people are sitting or standing, can occur in anyone who has recently had a spinal cord impairment. It occurs in people especially if it is the first time the person is getting out of bed and into a wheelchair. It can also occur as people sit up in the wheelchair for longer periods of time.

Orthostatic hypotension is a major concern in people who have injuries above the thoracic six (T6) level due to the loss of the sympathetic nervous system control. Orthostatic hypotension can occur when changing positions from lying down to sitting up or when eating or drinking. The person can feel dizzy, light-headed, or sick to their stomach. They also could complain of “seeing stars” or yawning a lot. The reason why this happens is that the body’s normal reaction to these events is to cause the vessels to become smaller so that the heart is able to get more blood back to it. Due to the spinal cord injury, this does not happen, so blood stays where it has gone. This could be the stomach cavity and the legs as they hang down when the person is sitting in the wheelchair or when he or she is in a standing frame.

Therapy and nursing will try many things to try to prevent you from complaining of dizziness. These include wearing the elastic stockings with or without elastic bandages on top of them, wearing an abdominal binder and using elevating leg rests on the wheelchair. These items try to prevent blood from going into areas and staying there. The elastic stockings, elastic bandages and abdominal binder help to constrict the areas so blood is given back to the heart in the most efficient manner. The leg rests do not allow the legs to hang down as much so that the blood is encouraged to go back to the heart.

Autonomic dysreflexia is also one of the cardiovascular medical complications. It is also most commonly seen in people who have a lesion above the thoracic six (T6) area after a few months from the spinal cord impairment. Autonomic dysreflexia is caused by a change in the brain’s control over the sympathetic nervous system. The sympathetic nervous system causes blood vessels to constrict, but with autonomic dysreflexia, the brain’s influence over the sympathetic nervous

systems' control center is not working properly. Therefore, the person can experience elevated blood pressure, headache, blurred vision, stuffed nose and sweating. It is important to get the blood pressure lowered, so the first step is to get into a sitting position, and then identify the cause of the problem. Many causes exist, including constipation, skin ulcers and ingrown toenails, but the most common cause is a kink in the catheter tubing, which will not allow the urine to flow into the catheter bag. These problems should be fixed immediately to prevent the problem from occurring again.

Deep vein thrombosis (DVT), or blood clot, is caused by a decrease in tone in the lower extremities, which decreases the return of blood to the heart. Also happening at the same time is an increased number of red blood cells that stick together. This is called *increased coagulability*. Most people are put on blood thinners to prevent this from becoming a problem. The medical staff works hard to make sure this does not become a problem because another medical complication could result. This problem is called an *embolism* and results when a portion of the blood clot detaches and travels in the body. Sometimes this traveling embolism is very small, but it could be larger and prevent blood from flowing normally in the body.

Normally, a blood thinner will keep the blood clot from forming, but most doctors want people to wear elastic stockings on the legs also. Sometimes, surgery to insert a filter may be recommended to catch the traveling clots and prevent problems in the long run.

Heart complications can occur after a spinal cord injury also. Normally, during the first six weeks after the injury, the pulse may drop down. This is because the autonomic nervous system is interrupted. The decreased pulse should level out in time.

The other way heart complications occur is due to a lack of exercise. The muscles tend to become weaker in the legs, arms and trunk. The muscles that remain active may not be able to pump the blood back to the heart very well. Without the increase in blood back to the heart, it does not have to work very hard, so it gets weaker. This weakness in the heart can continue, especially as the person gets older.

Another heart problem that exists after spinal cord injury is the decreased ability of the heart to respond during exercise. Prior to the spinal cord injury, when people exercise, the pulse increases and blood gets pumped throughout the body. Due to the change in the sympathetic nervous system control, the pulse does not increase as it should when you exercise.

Patients with spinal cord impairment, who do not exercise regularly, may also have low cholesterol levels of the high-density lipoprotein (HDL). This has been shown to be a risk factor for cardiovascular disease. Smoking cigarettes and cigars has been shown to increase a person's risk for cardiovascular disease also. When a person smokes, the blood flow is decreased to the legs and arms and the circulation of oxygen throughout the body is limited.

Other risk factors for cardiovascular disease include a lifestyle where you are not very active. For example, if you spend a lot of time watching TV or working at a job that requires only minimal exercise, and you do not have an exercise schedule, you can increase your risk of cardiovascular disease. If you do exercise regularly and are able to work out for over twenty minutes, your endurance for exercise will steadily increase, which will decrease your risk for heart disease. Having increased body fat is another risk factor for heart disease. People with spinal cord injury can have increased body fat and decreased lean tissue muscle mass as it is much easier to gain weight after the spinal cord injury. The amount and types of food that you need to eat to maintain your body at the level it was prior to the impairment is changed. If you are spending a large portion of your day just sitting, you will not need to consume a lot of food to maintain your weight.

Some activities that your doctor and your therapists may recommend include an arm bike exercise program, using the computerized bike for the legs, swimming, working out with weights, propelling your wheelchair around a track or around your home, joining the rowing club or basketball team. These exercises need to be done consistently and for a period of time that is determined to benefit you most. The activities listed above are probably exercises that you have done in the past. You will be able to try a few of them while you are doing your rehabilitation. If you show an interest in other activities, your therapists can show you ways to do these.

For example, the arm bike is something that you probably haven't used before. It works by using your arms to pedal a bike that sits on top of a counter. This will help your arms get stronger and give your heart a workout. The computerized bicycle for the legs works by having electrodes placed on the front of your legs, the back of your legs and your buttocks. These electrodes are connected to cables that hook into a computer, which controls the motion of pedaling a bike. The computerized bicycle program is a part of the NES program, which stands for Neuromuscular Electrical Stimulation.

Another part of this program is the Parastep® program. In the Parastep® program, electrodes are placed on your legs similar to the computerized bike. However, in the Parastep® program, the electrodes are connected to a computer and a walker and allow some people to take a few steps. The Parastep® program and computerized bicycle ergometer are used as exercise tools to decrease the cardiovascular problems that you can have after a spinal cord injury. The NES program is appropriate only for some people with spinal cord injury. If you are wondering if you can enter the program, check with your physical therapist and case manager.

The other activities mentioned such as swimming, basketball and rowing can be done individually or in a group. The recreational therapist will be able to work with you to identify the places to go for these activities.

# Glossary

---

<b>Arteries</b>	Large blood vessels that carry oxygenated blood away from the heart to other parts of the body.
<b>Autonomic Dysreflexia</b>	Response of the body to stimulation below the level of injury marked by symptoms such as high blood pressure, sweating, “goose bumps,” nasal stuffiness, pounding headache or a combination of these symptoms.
<b>Autonomic Nervous System</b>	Primarily made up of fibers from spinal nerves and can be subdivided into two divisions: sympathetic nervous system and parasympathetic nervous system. Each division balances the activity of the other to keep the body functioning.
<b>Capillaries</b>	Very small blood vessels that connect to arterial (arteries) and venous (veins) systems.
<b>Cardiovascular</b>	Pertaining to the blood vessels and heart.
<b>Constriction</b>	To squeeze or compress.
<b>Deep Vein Thrombosis (DVT)</b>	A blood clot.
<b>Embolism</b>	A blood clot that detaches and travels through the body.
<b>Orthostatic Hypotention</b>	Lowering of the blood pressure when changing positions (e.g., from a lying position to an upright position).
<b>Parasympathic</b>	The parasympathic division of the autonomic nervous system is concerned with maintaing bodily functions during ordinary circumstances that are not stressful (e.g., food digestion and urination).
<b>Sympathic</b>	The sympathetic division of the autonomic nervous system is concerned with bodily functions while under stress (e.g., the body sweating as a means to cool down).
<b>Veins</b>	Blood vessels that carry waste-filled blood back to the heart.

---

# References

1. Frownfelter D, Dean E. *Principles and Practice of Cardiopulmonary Physical Therapy (3rd ed)*. Philadelphia, PA: Mosby, 1996.
2. Lazarski M, Sinnott M. *Role of the physical therapist in management of patients with acute spinal cord injury*, in Hochschuler SH, Cotler HB, Guyer RD (eds): *Rehabilitation of the Spine: Science and Practice*, St. Louis, MO: Mosby-Year Book, Inc, 1993.
3. Locket K, Keyes A. *Conditioning with physical disabilities. Conditioning with spinal cord injuries, spina bifida, and poliomyelitis*. Champaign, Ill: Human Kinetics, Inc, 1994.
4. O'Sullivan S, Schmitz T. *Physical rehabilitation assessment and treatment (3rd ed). Traumatic spinal cord injury*. Philadelphia, PA: F.A. Davis Company, 1994.
5. Washburn RA, Figoni SF. High density lipoprotein cholesterol in individuals with spinal cord injury: The potential role of physical activity. *Spinal Cord*. 37, 685-695, 1999.
6. Consortium for Spinal Cord Medicine. *Prevention of thromboembolism in spinal cord injury*. Washington, DC: Paralyzed Veterans of America, 1997.
7. Consortium for Spinal Cord Medicine. *Autonomic Dysreflexia: What You Should Know*. Washington, DC: Paralyzed Veterans of America, 1997.



# Comments and Feedback

The staff of the center has recently spent a lot of time and effort in revising this manual. However, we realize that those who are actively reading and using the manual can improve it. As a part of our program of continuous quality improvement, we ask you to help guide our efforts to improve the manual.

In the next section of the chapter are two forms. The first form is an overview by chapter that seeks to identify those areas of the manual that could benefit the most from additional work. We also seek to identify any major areas of concern that have not been addressed.

The second section is a more focused questionnaire that has as its goal the specific items that should be targeted. For example, should an item be added to the glossary or the definition changed. Should a drug be added to the discussion of bowel programs?

The more specific the comments are the more likely that we will be able to make the improvements that form the basis of your idea. By communicating with the Regional Spinal Cord Injury Center of the Delaware Valley, however, users grant us permission to use any information, suggestions, ideas, drawings or concerns communicated for any purpose we choose, commercial, public or otherwise, without compensation or acknowledgement whatsoever.

Thank you for taking the time to assist us in improving this manual.

Sincerely,

SCI Manual Committee

Regional Spinal Cord Injury Center of the Delaware Valley  
Thomas Jefferson University Hospital  
132 S. 10th Street  
375 Main Building  
Philadelphia, PA 19107



# Feedback Form

Rate each chapter by placing an “X” on the scale underneath the term that best captures your opinion. Using the next page, provide specific comments regarding your ratings. Feel free to make copies of the next page.

	No Opinion	Fair	Satisfactory	Good	Excellent
<b>Credits / Front Matter</b>					
<b>Table of Contents</b>					
<b>Introduction</b>					
<b>Spinal Cord Injury</b>					
<b>Bladder</b>					
<b>Bowel</b>					
<b>Respiratory</b>					
<b>Respiratory Dependent</b>					
<b>Skin</b>					
<b>Cardiovascular</b>					
<b>Nutrition</b>					
<b>Activities of Daily Living</b>					
<b>Equipment</b>					
<b>Mobility</b>					
<b>Psychology</b>					
<b>Vocational Services</b>					
<b>Recreational Therapy / Resource Guide</b>					
<b>Travel and Transportation</b>					
<b>Sexuality</b>					
<b>Spinal Cord Injury Follow-Up Care System</b>					
<b>Master Glossary</b>					

# Suggestions and Comments

Chapter: \_\_\_\_\_

Page(s): \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Any terms that need to be added to the glossary? How would you define the terms?

Any section or paragraph that was not clear?

Any drawing or sketch that would help to illustrate the material being covered?

Any additional topic that should be covered?

Any questions you have that you feel should have been answered by the manual?

What is the question?

What is the suggested answer?

Any references that should be added? Any other resources that should be mentioned?

**By communicating with the Regional Spinal Cord Injury Center of the Delaware Valley, however, users grant us permission to use any information, suggestions, ideas, drawings or concepts communicated for any purpose we choose, commercial, public or otherwise, without compensation whatsoever.**

