

SPINAL CORD MEDICINE

HANDBOOK FOR PATIENT AND FAMILY



Anatomy of Spinal Cord, Facts & Figures About Injury



Frazier Rehab Institute

A service of Jewish Hospital & St. Mary's HealthCare

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TABLE OF CONTENTS

Chapter 1 Comprehensive Rehab

Your Spinal Cord Medicine Team
After Discharge from the Rehab Hospital
You and Your Family are Team Members

Chapter 2 Anatomy of Spinal Cord, Facts and Figures About Injury

Chapter 3 Bowel Care

The Digestive System and Bowel Function
Bowel Management Program

Chapter 4 Bladder Care

The Urinary System
Bladder Programs
Urinary Tract Infections

Chapter 5 Skin Care

Risk Factors for Skin Breakdown
Stages of Skin Breakdown
Treatment
Prevention of Skin Breakdown

Chapter 6 Medical Concerns

Autonomic Dysreflexia
Deep Vein Thrombus (DVT)
Heterotopic Ossification (HO)
Orthostatic Hypotension
Spasticity

Chapter 7 Lung Care

Normal Anatomy and Physiology
Pathology
Level of Injury and Respiratory Function
Pulmonary Hygiene
Warning Signs of Respiratory Problems

Chapter 8 Cognition, Communication and Swallow

Cognition and Communication
Swallowing
Preventing Pneumonia
Staying Hydrated
Quality of Life

Chapter 9 Nutrition

Soon After Injury
Once Medically Stable
Ideal Body Weight After Injury
Health Issues and Nutrition
A Primer on Nutrients

Chapter 10 Self Care and Activities of Daily Living

Dressing
Bathing
Toileting
Grooming and Hygiene
Feeding

Chapter 11 Mobility

Range of Motion
Pressure Relief
Transfers

Chapter 12 Equipment

Wheelchairs and Cushions
Splinting
Assistive Technology

Chapter 13 Home Modifications

Chapter 14 Psychological Care

Grief and Loss
How Families Can Help
Family Members Struggle Too
Caregivers
Depression
Substance Abuse
Brain Injury

Chapter 15 Human Sexuality

For Females
For Males
Fertility

Chapter 16 Recreation and Wellness

Chapter 17 Glossary

Chapter 18 Resource Guide

THE PATIENT AND FAMILY HANDBOOK

This Handbook is designed to give you the information to better understand spinal cord injury and the tools needed to manage your health care needs successfully. Information is intended for you and your family because, those who love you, will often be involved in assisting you with your care needs while in the hospital, and in the home environment. As you read through the Handbook, your rehab team at Frazier is available to address your questions and provide you more information pertinent to your needs.

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A BRIEF NOTE ABOUT THE FOUNDER OF FRAZIER REHAB INSTITUTE

In her early 20's, Amelia Brown of Louisville sustained a spinal injury in a car accident in the 1940's. With no rehabilitation services in Louisville, she traveled to New York for treatment. After returning to Louisville, she married a physician, Dr. Harry Frazier. Believing Louisville needed its own rehabilitation facility, Mrs. Frazier founded the Frazier Institute of Physical Medicine and Rehabilitation in the early 1950s. Her son, Owsley Brown Frazier, served as Chairman of the Fund Raising Committee for Frazier's new building, named the Frazier Rehab and Neuroscience Center, which opened in 2006.

DISCLAIMER

The information contained herein is intended to be used in accordance with the treatment plan prescribed by your physician and with the prior approval of your physician. You should not begin using any of the methods described in this publication until you have consulted your physician. Jewish Hospital & St. Mary's HealthCare, Inc. D.B.A. Frazier Rehab Institute, its affiliates, associates, successors and assigns, as well as its trustees, officers, directors, agents and employees are not liable for any damages resulting from the use of this publication.

Note: Words *italicized* below are defined in the Glossary at the end of this Chapter.

ANATOMY OF SPINAL CORD, FACTS AND FIGURES

KEY POINTS

- The spinal cord is the major neurological communication link between the brain and the body and has some independent neurological functions of its own
- Damage to the spinal cord can result from various forms of trauma, interruption of blood supply, direct pressure or central nervous system diseases
- Spinal cord nerve tissue either does not re-grow or heals very slowly (depending upon the tissue) but modern science is producing evidence that regeneration of spinal cord function could become a reality
- The *level of injury* identifies the lowest place or section of the spinal cord where function is normal. Any damage to the spinal cord happens below the level of injury. Where damage has occurred to the spinal cord may or may not coincide with injury to the bony (skeletal) level of the spinal column. Therefore level of injury identifies a functional level.
- *Incompleteness* or *Completeness* of injury (functional deficit) are terms defined by whether or not nerve messages pass through the damaged spinal cord site (incomplete – partial passage; complete – no passage).

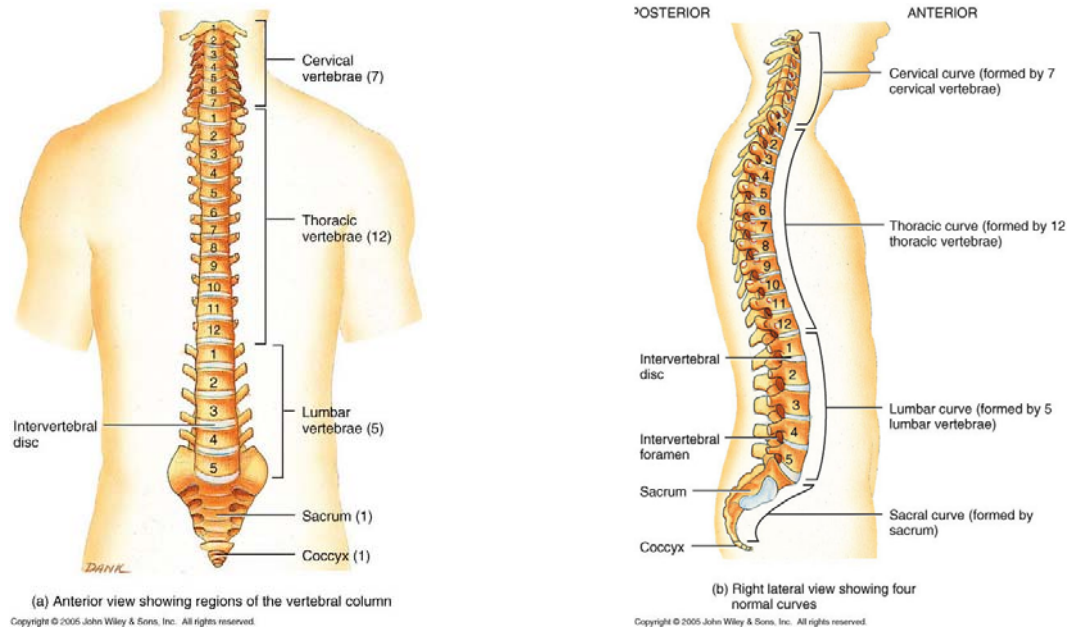
THE SPINAL CORD

The spinal cord is the largest and most complex single extension of the nervous system. It is made up of many specialized collections of nerve fibers that begin in the brain and extend down through the bony canal in the *spinal column* (commonly called the backbone) and out into the body. The cord itself is about a half inch in diameter and is soft and pliable but surprisingly strong. It is nourished by many small blood vessels that carry oxygen-rich blood and nutrients to its cells and connective tissue but this blood supply is very susceptible to damage or obstruction and is one of the spinal cord's potential weaknesses. Because it is so complex in its neurological composition, a little damage could potentially create a great deal of functional interference and the communication the cord provides could either be halted altogether or become jumbled or confused creating havoc in bodily functions.

THE SPINAL COLUMN AND INJURY

Individual bones called vertebrae make up the spinal column. The vertebrae are stacked basically one on top of the other and surround the spinal cord in a canal, which serves as protection for the cord itself and other elements within the canal. The spinal column is comprised of 7 *cervical* (neck) vertebrae, 12 *thoracic* (chest and rib cage) vertebrae, 5 *lumbar* (lower back) vertebrae, and 5 fused *sacral* (tailbone) vertebrae. Therefore, there are 29 vertebrae in the spinal column. The entire column of bones is held together by a complex system of ligaments, muscles, and tendons that provide stability of the column and at the same time use the column to support body movement. Between each of the vertebrae there

is a tough, fibrous *disc*, which acts like a hydraulic cushion, preventing the vertebrae from rubbing against one another and also protecting the spinal nerves that extend from the spinal



cord to the rest of the body. One can readily see that anything that disrupts the integrity of the spinal column can result in injury to the spinal cord or its spinal nerves or both. Spinal nerves are branches of the spinal cord that extend outward from the cord between the vertebrae to parts of the body.

- Nerves that branch out from the neck or cervical region (C_1 through T_1) control muscles and sensory functions in the shoulders, arms, wrists, fingers and the large breathing muscle called the diaphragm
- Nerves that branch out from the trunk or thoracic area (T_2 through T_{12}) control muscle and sensory functions that lend balance to sitting and standing and enhance rib cage control to augment breathing and coughing
- Nerves that branch out from the lower back (L_1 through L_5) and tailbone (S_1 through S_5) control muscles and sensory functions of the lower extremities as well as control bowel, bladder and sexual functions.

The brain sends messages down the spinal cord to the *motor nerves*, which control the movement of muscles. *Sensory nerves* send signals back to the spinal cord and then the brain so we can feel hot, cold, touch, pain and pressure. Injury can affect the working of either the motor nerves or the sensory nerves or both.

In a *complete spinal cord injury*, nerve damage stops all messages from passing through the site

where the injury occurred. In an *incomplete spinal injury*, some messages continue to pass through or around the injury site meaning that the spinal cord was not totally damaged. Immediately or shortly after injury, a person may appear to be a complete injury with no motor or sensory input below the level of the injury. However, after the swelling of the spinal cord goes down, some complete injuries are re-classified as incomplete. After the swelling goes down in an incomplete injury, there may be significant improvement in motor and/or sensory function.

The spinal cord is kept alive by the flow of blood (through arteries) that carries oxygen and nutrients into the cells, and removes carbon dioxide and waste products (through veins). Swelling in the spinal cord can cause the flow of blood to be altered or stopped. Disruption in the flow of blood servicing the spinal cord can cause damage or death to spinal cord cells. Standard treatment for traumatic spinal cord injuries includes the administration of a steroid drug called methylprednisolone, which if given in the first few hours after injury, can decrease swelling in the spinal cord. Unfortunately, cells that die in the spinal cord are not replaced with new cells that serve the same purpose as the cells that died. However, scientific advancements in the future may prove otherwise. See Resources at end of the Chapter.

Other ways the spinal cord can be injured include:

- *Contusion* - bruising of the spinal cord which can occur when the cord is thrown hard against the vertebrae as in a whip lash injury
- *Compression* - pressure on the spinal cord which can be caused by a ruptured disc, broken vertebrae or tumor
- *Severed or lacerated* - a cut of the spinal cord sometimes caused by a knife or bullet
- Disease and infections such as *Multiple Sclerosis*, *Transverse Myelitis*, *Friedreich's Ataxia* and *Amyotrophic Lateral Sclerosis (ALS)*
- Birth defects such as *Spina Bifida* where the spinal cord fails to develop normally early in pregnancy

Paraplegia refers to injury or impairment in the thoracic (T₂ through T₁₂); lumbar L₁ through L₅); or the sacral (S₁ through S₅) regions of the spine that affects functioning of the lower two extremities that being the legs. *Tetraplegia*, once called quadriplegia, refers to an injury or impairment in the cervical spine (C₁ through T₁) that affects all four limbs meaning both arms and legs.

Level of Injury refers to the lowest level where the spinal cord is functioning normally. Thus, a C₅ injury would indicate that the spinal cord and all nerves at C₅ and above are functioning normally. Thus, the injury to the spinal cord would be below C₅.

WHO GETS INJURED AND HOW

Prevalence. In the United States, there are approximately 40 new cases of spinal cord injury per million or 11,000 new injuries each year. These figures do not include those who die at the scene of the accident. There are approximately 250,000 people in the United States living with spinal cord injury.

Age and Sex. Spinal cord injuries occur most frequently in young adults. In the 1970's most injured were between 16-30, average age was 28.7. Since 2000, the average age of injury is 37.6 years. Approximately ten percent of all injuries were sustained by individuals over the age of 60. Approximately 80 percent of all injured are males.

Cause. Motor vehicle accidents cause 47.5 percent of all spinal cord injuries; 22.9 percent are due to violence: 22.9 percent due to falls; 8.9 percent due to sports accidents; and 6.8 percent to other causes.

Ethnic Groups. Among those injured, 62.9 percent were Caucasian; 14.2 percent were African American; 12.6 percent were Hispanic; and 2.5 percent were from other racial/ethnic groups.

Level of Injury. Most frequent neurological category at discharge was incomplete tetraplegia (34.5 percent), followed by complete paraplegia (23.1 percent), complete tetraplegia (18.4 percent) and incomplete paraplegia (17.5 percent). Less than one percent experienced a full neurological recovery at discharge from the hospital. There has been a slight increase in the number of those with incomplete tetraplegia, a slight decrease in the number of those with complete tetraplegia and complete paraplegia.

Mortality. Prior to new antibiotics in the 1950's, those with spinal cord injury lived on average less than two years typically dying of urinary tract infections. Today, the leading cause of death is pneumonia followed by heart disease and sepsis, an infection spread throughout the body.

Those who became paraplegic in their 20's and survived at least one year after injury, live an average of 46 more years compared to 58 years for the general population. Those with low level tetraplegia (C₅ through C₈) live an average of 41 years after injury; those with high level tetraplegia (C₁ through C₄) live an average of 38 years after injury.

Length of Stay. National statistics indicate that average number days in the acute care hospital after injury is 19 days (2003). Average number of days in in-patient rehabilitation is about 45. Length of stays vary considerably in both the acute care and rehab settings depending upon medical complications, level of progress and many other issues.

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www.spinalcord.uab.edu - University of Alabama at Birmingham

www.spinalcord.org - National Spinal Cord Injury Association

GLOSSARY

AMYOTROPHIC LATERAL SCLEROSIS (ALS) - A progressive neurological disease affecting motor neurons that is considered fatal.

CERVICAL - The neck region with 7 vertebrae and 8 spinal nerves.

COMPLETE SPINAL CORD INJURY - An injury to the spinal cord where no neural signals are communicated past the level of injury, either from the brain to body parts below the injury or sensory signals from the lower body to the brain.

COMPRESSION - Pressure on the spinal cord that can disrupt or stop the flow of information up and down the spinal cord.

CONTUSION - A bruise on the spinal cord that can disrupt or stop the flow of information up and down the spinal cord.

DISC - The cushion between each vertebrae of the spine that acts as a shock absorber.

FRIEDREICH'S ATAXIA - A progressive disease affecting the nervous system impacting muscles used for movement, bowel and bladder control, speech and heart function.

INCOMPLETE SPINAL INJURY - An injury to the spinal cord where some neural signals are communicated past the level of injury, either from the brain to body parts below the injury or sensory signals from the lower body to the brain.

LEVEL OF INJURY - Refers to the lowest level where the spinal cord is functioning normally.

LUMBAR - Refers to the low back region that includes five vertebrae between the thoracic and sacral regions.

MOTOR NERVES - Nerves that carry information from the brain to muscles for muscles

to contract, create movement.

MULTIPLE SCLEROSIS - A disease that attacks the myelin, the insulator to nerve fibers, causing slowing or blockage of nerve signals.

SACRAL - Refers to the lowest region of the spinal column sometimes called the tailbone.

SENSORY NERVES - Nerves that carry information back to the brain related to hot, cold, touch, pain and pressure.

SEVERED - Spinal cord partially or totally cut in two.

SPINA BIFIDA - During pregnancy, the spinal cord fails to develop normally which causes muscle weakness and/or paralysis after birth.

SPINAL COLUMN - Also know as the spine or backbone contains 26 vertebrae or bones.

TETRAPLEGIA - Formally quadriplegia, loss of motor and/or sensory function in the arms, trunk and legs caused by injury or disease to the cervical (neck) segments of the spinal cord.

THORACIC - The region involving 12 vertebrae in the spine that runs from the shoulder to the lower ribs. This region is below the cervical region and above the lumbar region.

TRANSVERSE MYELITIS - Disorder caused by inflammation of the spinal cord often associated with infection though the cause is not fully known. Can result in muscle weakness and/or paralysis.

VERTEBRA - A single bone in the spinal column.