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Spinal cord injury:

A lifelong condition

Timely and appropriate management of patients with this type of injury is essential to ensure survival. Learn about the nurse's role in patient care and prevention.

By Amanda Perkins, DNP, RN

Often caused by preventable trauma, such as motor vehicle crashes, falls, or violence, spinal cord injury (SCI) can cause changes in motor, sensory, autonomic, and psycho-affective functioning, leading to disability and, in the worst-case scenarios, death (see *By the numbers*). Nontraumatic SCIs may be caused by vertebrae degeneration, bone spurs, infections, tumors, and spinal cord disease such as multiple sclerosis. Patients with an SCI will spend a significant amount of time in healthcare settings and face substantial medical costs.

This article provides information on SCI, including a review of anatomy and physiology, the types of SCI, complications, treatment, and prevention.

The body

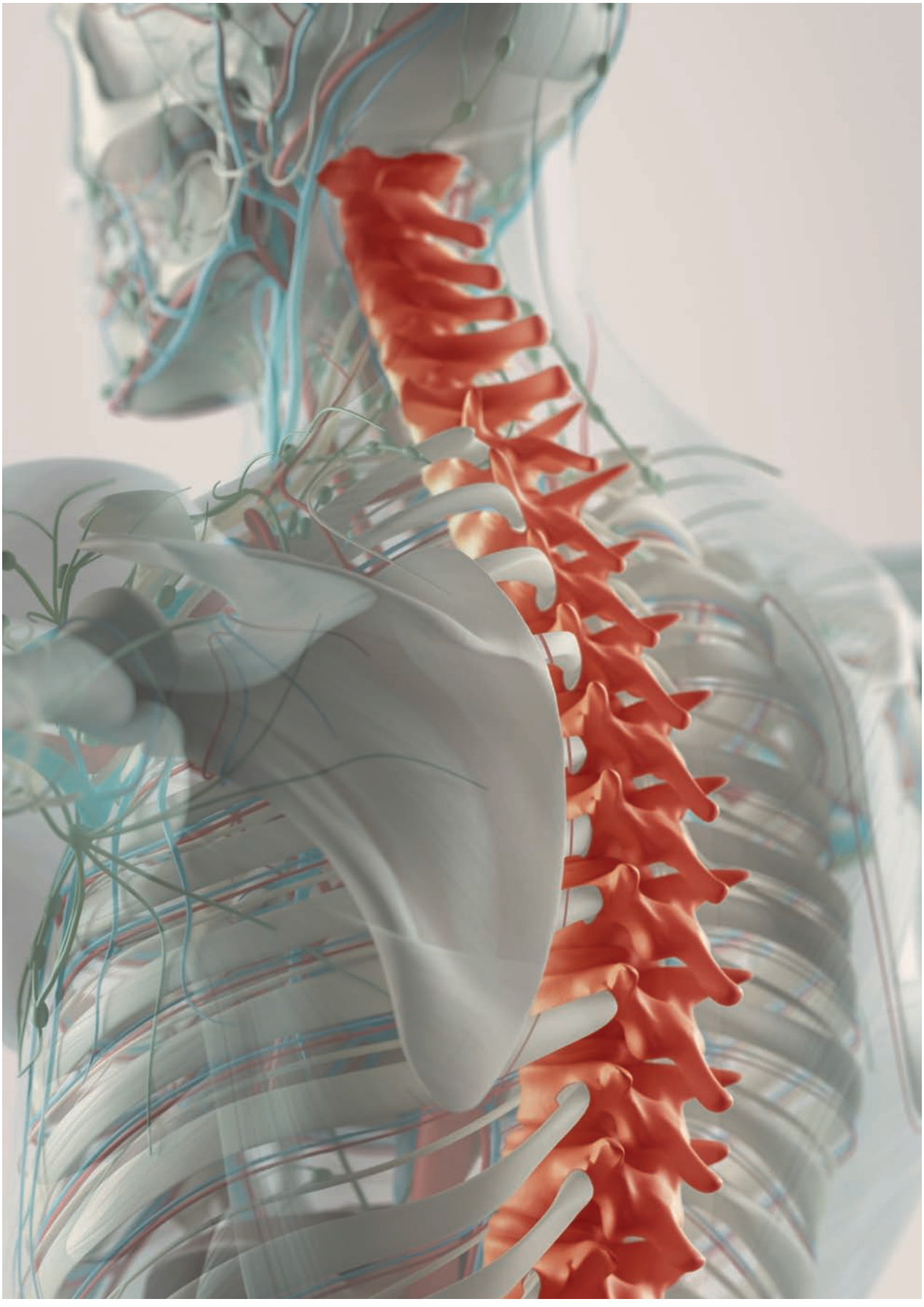
When a patient sustains an SCI, a variety of changes occur in the body. Before discussing these changes, let's briefly discuss the spine's anatomy and physiology. The spinal cord extends from the base of the brain to the lower back (see *Anatomy and injuries of the spine*). It transmits information from the body to the brain and from the brain to the body. The combination of the brain and spinal cord make up the central nervous system. Communication between the brain, spinal cord, and body is essential for vital signs maintenance and the ability to move, urinate, and have a bowel movement.

The nerves in the spinal cord control voluntary and involuntary actions. The placement of the spinal nerves is as follows:

- cervical—C1 to C8
- thoracic—T1 to T12
- lumbar—L1 to L5
- sacral—S1 to S5.

The cervical spinal nerves emerge at the base of the neck and are associated with the head, neck, shoulders, arms, hands, and diaphragm. When caring for a patient with a suspected SCI, it's important to understand the correlation between the diaphragm and injuries that are high on the body to improve respiratory support.

The thoracic spinal nerves emerge at the upper mid back and are associated with the chest muscles; some muscles in the back; and some organ systems, particularly those in the abdomen.



ANATOMY INSIDER / SHUTTERSTOCK

The lumbar spinal nerves emerge at the low back and are associated with the abdomen, buttocks, some parts of the genital organs, and parts of the legs.

The sacral spinal nerves emerge in the lower back and are associated with the legs, feet, external genital organs, and the area around the anus.

The spinal nerves are protected by the vertebrae in addition to disks, ligaments, and muscles. There are 33 vertebrae that help protect the spinal cord and each has a hole, referred to as the spinal canal. The spinal canal houses the spinal cord. In between each vertebra is a disk, which is the spine's shock absorber. The spinal cord has sensory and motor tracts that allow for sensation and movement. Damage to the patient's sensory tract will alter his or her ability to feel and recognize sensations, such as pain or temperature changes. Motor tracts are responsible for body movement. Damage to the motor tracts can lead to problems with movement, ranging from weakness to a complete inability to move. Trauma to the spinal cord can lead to ischemia, bruising, fractures, and dislocation.

Within minutes of an SCI, the area surrounding the injury will begin to swell, which, in turn, increases pressure and disrupts blood flow. When this occurs, the patient may have a dramatic decrease in BP because the swelling and disrupted blood flow alters the body's ability to self-regulate, known as spinal shock or neurogenic shock (see *Spinal shock*). It's important to note that some sources differentiate spinal shock and neurogenic shock, classifying spinal shock as the loss of all function below the injury and neurogenic shock as the circulatory issues that develop, such as vasodilation, bradycardia, and hypotension.

By the numbers

In 2018, it was estimated that 247,000 to 358,000 individuals in the US were living with an SCI, according to the National Spinal Cord Injury Statistical Center. Approximately 78% to 80% of SCIs occur in men. Of preventable causative factors, motor vehicle crashes make up the majority of cases, followed by falls and violence. The breakdown of causes is as follows:

- motor vehicle crashes—38.8%
- falls—31.6%
- violence—13.8%
- sports—8.2%
- other causes—7.6%.

Since the 1970s, there's been an increase in the age of individuals experiencing an SCI. The average age for a person to develop an SCI was 29; the current average is age 43. It's interesting to note that in the 1970s, the average hospital stay was 24 days and the average rehabilitation stay was 98 days. Today, the average hospital stay is 11 days and the average rehabilitation stay is 34 days. Approximately 30% of patients with an SCI will be readmitted to the hospital at least once within the first year of sustaining the injury. When readmitted, the average length of stay is 22 days. The leading causes of readmission are genitourinary disorders and skin disorders.

Types of SCI

SCIs can be complete or incomplete. With a complete SCI, communication between the brain and spinal cord doesn't occur and the patient will have a complete lack of sensory and motor function. With an incomplete SCI, communication between the brain and spinal cord is altered but not completely lost.

SCIs can be further classified as sensory incomplete or motor incomplete. With a sensory incomplete injury, sensory function is preserved below the injury but not motor function. With a motor incomplete injury, motor function is preserved below the injury but not sensory function.

In addition to being classified as complete or incomplete, SCIs are also classified as primary or secondary. Primary SCI represents the injury when it initially occurs; after the injury occurrence, it's referred to as secondary SCI.

At the time of the primary SCI, a damaging force or medical condition causes a

disruption to the axons, blood vessels, and cell membranes. In the primary injury phase, the following happens within 2 hours of sustaining the injury:

- traumatic physical injury (most often, but injury may be related to a disease process)
- severed axons
- gray matter hemorrhage and ischemia
- microglial (phagocytic cell) activation
- necrotic cell death
- release of proinflammatory factors.

The secondary injury phase starts within the first 48 hours and continues until at least 6 months. The lesion will expand to include adjacent white and gray matter. Hemorrhage and ischemia associated with decreased blood flow to the injured area will occur. Vasospasm, thrombosis, and edema also play a role in ischemia.

Within the first 48 hours, the following happens:

- hemorrhage
- ischemia
- necrosis
- neutrophil invasion
- free radical production
- edema
- oligodendrocyte (myelinating cell) death
- early demyelination
- neuronal death.

Within the first 14 days, the following will occur:

- maximal phagocytic response
- macrophage infiltration
- initiation of scar formation
- resolution of edema.

Lastly, over a 6-month period, scar formation continues and the lesion will stabilize.

Signs and symptoms

The signs and symptoms associated with an SCI are dependent on a variety of factors, including severity and injury location. In patients with an SCI, the functional loss that occurs is below the area of injury. A loss of function to most of the body, including the arms and legs, is called tetraplegia. An older term for this is quadriplegia, which is still commonly used today. Loss of function to the trunk and lower extremities is called paraplegia.

Broadly speaking, the patient with an SCI will have partial or complete loss of the following: sensory or motor function; the ability to regulate bowel or bladder; and the ability to regulate heart rate, breathing, and BP. Approximately one-third of patients with neck injuries will require assistance with breathing. Injuries at the C1 to C4 level affect the phrenic nerve, which goes to the diaphragm and aids in breathing. These patients may also have difficulty regulating their temperature.

Many people associate an SCI with loss of sensation and function, which does occur, but it's important to understand that pain is also a common symptom. Often, the patient will develop neurogenic pain, which is associated with intense burning and stinging.

Spinal shock

When spinal shock occurs, the area below the injury stops functioning, resulting in complete paralysis, loss of reflexes, and loss of sensation. Approximately 50% of patients with an SCI develop spinal shock, lasting from several hours to several days. Although spinal shock can't be prevented, it can be medically managed. Patients with spinal shock should receive fluid resuscitation. Due to the risk of fluid overload, these patients must be monitored accordingly.

Improving survival

Regardless of the setting, caution should be taken with patients who may have an SCI and a thorough assessment should be completed. This section addresses care before and after admission to a healthcare facility.

Before admission to a healthcare facility, management of the patient with an SCI is essential. Emergency care is required for any patient with a suspected SCI. It's

extremely important that rapid recognition of potential injuries occurs in addition to immobilization of the head, neck, and spine to prevent potential complications, such as paralysis or cessation of breathing. When available, a rigid collar and backboard should be used. In some cases, the patient may need respiratory support.

Timely and appropriate care in the hospital setting is equally as important. When the patient arrives at the hospital, it's essential that he or she remains immobilized until evaluated and cleared by a healthcare provider. Moving the patient too quickly can result in permanent damage or injury. The number one priority is airway maintenance, followed by spinal cord protection.

Upon admission to the ED, a physical exam must be completed. The patient and/or anyone present with the patient should be asked about the mechanisms of injury to aid in diagnosis. In addition to the history and physical exam, diagnosis is made using MRI, computed tomography scan, and X-ray results. The patient should be evaluated for movement of the arms and legs, strength of the arms and legs, the ability to feel sharp versus dull and hot versus cold, and the ability to sense the body's position. It's important to determine if the patient's phrenic nerve has been damaged because phrenic nerve injury will lead to paralysis of the diaphragm.

Arterial blood gas (ABG) tests may be used to aid in the evaluation of breathing and oxygenation. The patient should have continuous oxygen saturation monitoring, and the nurse should also monitor for additional signs of ineffective oxygenation, such as altered mental status, breathing changes, and increased work of breathing. Report any abnormal findings pertaining to the respiratory system to the healthcare provider. Once the patient is stabilized, a complete neurologic exam should be completed.

Complications and secondary conditions

According to the World Health Organization, individuals with an SCI have a two- to fivefold increased risk of early death when compared with the general population, with the highest risk within the first year after the injury. Mortality is associated with the severity of the SCI. Additionally, cardiovascular complications are one of the leading causes of mortality and morbidity in these patients. Many complications are the result of inadequate care and/or resources. In patients with an SCI, the most likely cause of death is pneumonia and septicemia.

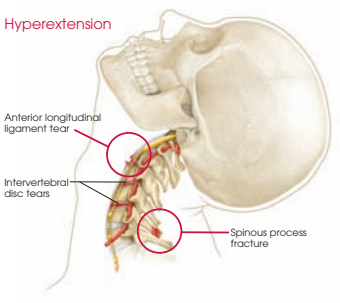
Conditions or complications associated with SCI include:

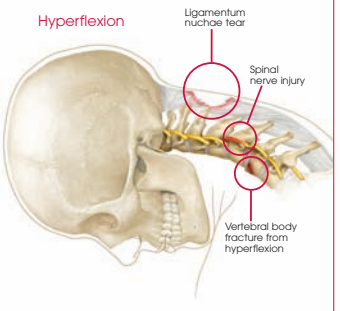
- deep vein thrombosis (DVT)
- urinary tract infection (UTI)
- pneumonia
- circulatory problems
- orthostatic hypotension
- spasticity
- pressure injuries
- chronic pain
- bowel and bladder problems
- sexual dysfunction
- substance abuse
- depression.

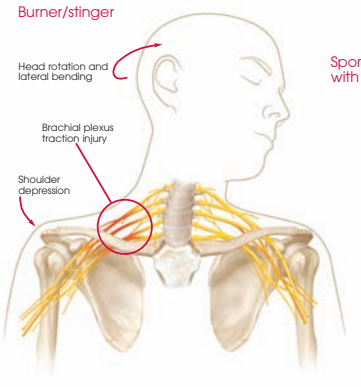
The risk of DVT is increased in the patient with an SCI because of a lack of movement. Implement preventive measures, such as range-of-motion exercises, sequential compression devices, and compression stockings. Patients with a chronic SCI may have a weakened immune system, making them more susceptible to infections, especially urinary and respiratory infections. The risk of infection increases with the use of mechanical ventilation, difficulty clearing the airways, and use of invasive devices such as urinary catheters. Practice appropriate infection prevention measures, including sterile suctioning for patients on mechanical ventilation and sterile catheter insertion, in addition to providing appropriate catheter care. UTIs and urinary reflux can lead to permanent kidney damage.

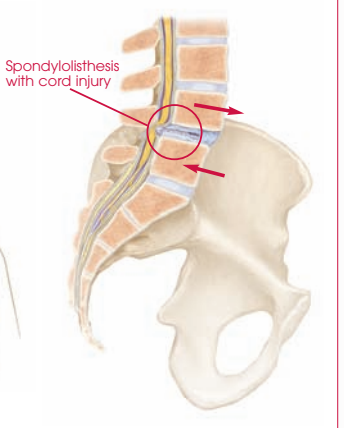
ANATOMY AND INJURIES OF THE SPINE

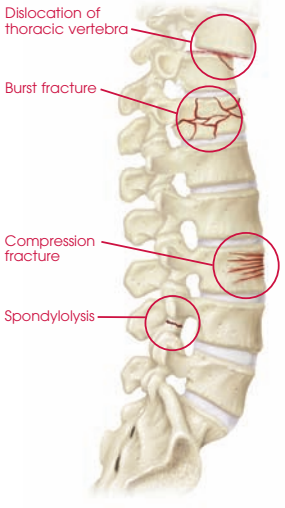
INJURIES

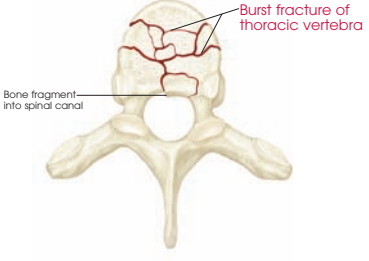


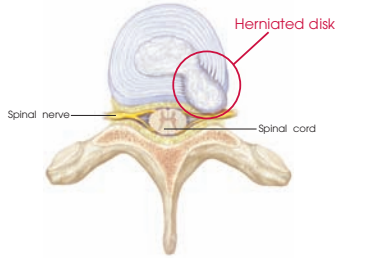


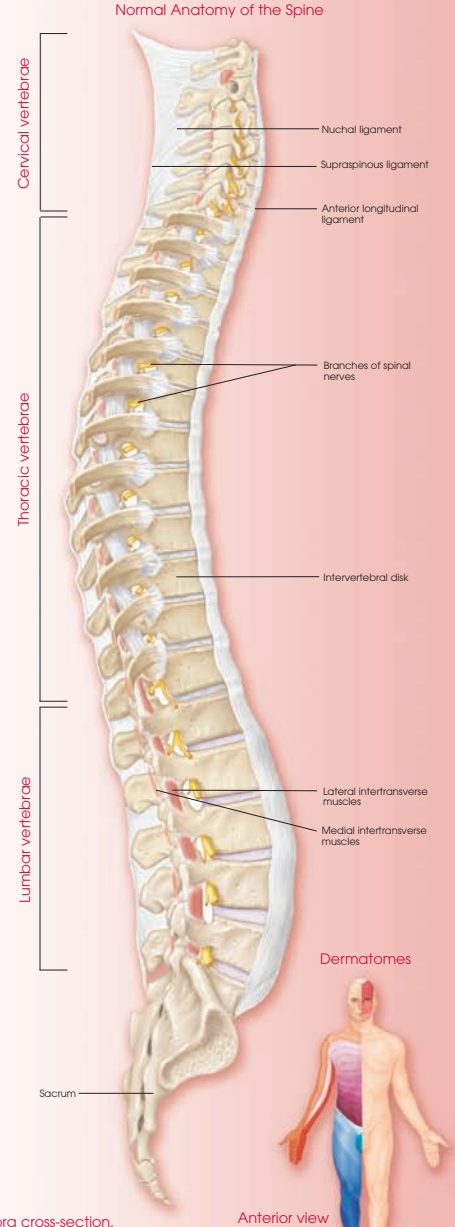


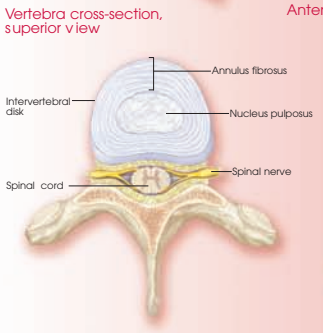












key points

Nursing interventions

- Immobilize the head, neck, and spine.
- Use a rigid collar and backboard when appropriate.
- Maintain a patent airway.
- Monitor vital signs.
- Ask about the mechanism of injury.
- Evaluate extremity movement and strength.
- Evaluate the ability to feel sharp versus dull.
- Evaluate the ability to feel hot versus cold.
- Monitor lab results, including ABGs.
- Monitor for signs and symptoms of respiratory difficulty.
- Complete a neurologic exam.

The circulatory problems that develop in patients with an SCI can lead to BP instability, arrhythmias, and blood clots. Orthostatic hypotension develops in these patients because they struggle with venous return due to a lack of muscular function and vasoconstriction. Blood pools in the legs with position changes and patients may report feeling dizzy. To prevent this, move the patient slowly and use compression stockings.

Spasticity can develop due to exaggerated reflexes. An inability to use the muscles can lead to muscle atrophy. Patients with an SCI are at increased risk for pressure injuries due to immobility and the inability to feel when the body needs to shift. Nursing measures to prevent a pressure injury include turning and repositioning, keeping skin clean and dry, addressing incontinence promptly, and ensuring adequate nutritional intake.

Another potential finding in the patient with an SCI is chronic pain, which can be frustrating for patients and make the recovery process more difficult. Be a patient advocate by assessing for pain, administering pain medication when needed, and requesting additional or different pain medication options for the patient if necessary. The patient with an SCI may have bowel and/or bladder problems leading to incontinence, retention, and constipation. The patient may also have problems with sexual function, which can increase stress and anxiety, as well as feelings of depression. Ask about sexual dysfunction and request referrals as appropriate. Among patients with an SCI, depression and substance abuse are common. As many as 30% of patients with an SCI show signs of depression. Report any signs and symptoms of depression or substance abuse to the healthcare provider.

Autonomic dysreflexia

Autonomic dysreflexia—the sudden onset of excessively high BP—is caused by irritation, pain, and/or stimulus to the nervous system, with the most common cause being a full bladder, followed by difficulty with bowel movements (see *Autonomic dysreflexia*). It's most commonly seen in patients with an injury to the neck and upper back at or above the T6 level. It also tends to occur in patients who've moved past the acute phase. In fact, many patients with autonomic dysreflexia will develop it for the first time approximately 3 to 6 months after the SCI occurred.

The noxious stimulus that causes autonomic dysreflexia occurs below the level of injury. When the patient's body perceives an irritation, such as a full bladder, it tries to send a signal about the irritation, but the signal becomes misdirected, which can negatively affect blood vessels and organs. The stimulus triggers an unregulated sympathetic cascade. The patient with autonomic dysreflexia will develop vasoconstriction as a result, leading to progressively worsening hypertension. Arterial BP becomes dangerously high and the systolic BP may be as high as 325 mm Hg.

When the patient develops hypertension, the body's baroreceptors increase parasympathetic signaling, which leads to bradycardia and peripheral vasodilation above the site of injury, as well as diaphoresis. Although bradycardia is often seen in patients with autonomic dysreflexia, tachycardia does develop in some cases.

In 88% of patients with an SCI, headache and sweating also develop.

Untreated autonomic dysreflexia increases the risk of stroke, myocardial infarction, retinal detachment, hypertensive encephalopathy, cardiac arrest, seizures and, in some cases, death. Recurring autonomic dysreflexia can lead to chronic cardiovascular and immune problems.

Treatment for autonomic dysreflexia is removal of the noxious stimulus. It's essential to identify the cause by completing a thorough assessment. Knowing that a full bladder and the inability to have a bowel movement are the two most likely causes of autonomic dysreflexia, assess for both and implement measures such as catheterization as needed. BP may fluctuate and should be monitored as often as every 2 to 5 minutes.

In some cases, nitroglycerin may be used for the management of autonomic dysreflexia. In most cases, 2% nitroglycerin paste will be applied above the level of the injury. Once a therapeutic effect has occurred, the paste can be removed. In the hospital setting, it's common to see I.V. nitroglycerin ordered because it has a more rapid effect. Additional medications that may be used include steroids and other vasoactive drugs.

Treatment

A multidisciplinary treatment team is necessary for patients with an SCI. Treatment may be surgical or nonsurgical.

The patient with an SCI may need to be immobilized. For some patients, skeletal traction may be needed. Surgical intervention may be required to evaluate the extent of the injury, stabilize the spine, and relieve pressure. Stabilization of the spine is essential to allow for early mobilization, which decreases the risk of complications associated with immobility. Surgery may also be needed to manage and stabilize any additional injuries that developed with the SCI.

For some patients, intubation and mechanical ventilation are necessary either for a short period of time or long term. In general, patients with C4 to C5 injuries will have respiratory impairment, often requiring respiratory support. In some patients, phrenic nerve stimulation may help them breathe without the use of a ventilator by causing the diaphragm to contract, giving them a greater level of freedom. Electrodes are placed on the patient's phrenic nerves and a transmitter is used to send a signal to the electrode receivers. The resulting nerve stimulation makes the diaphragm contract at a set respiratory rate. Typically, when this breathing aid is used, a mechanical ventilator will still be required at night to decrease the risk of stimulation device failure while the patient is sleeping.

Bowel training may be needed for the patient with an SCI. Focus should be placed on diet, medications, and digital stimulation. With diet in mind, some

Autonomic dysreflexia

The following preventable factors are associated with autonomic dysreflexia:

- full bladder
- constipation
- tight clothing
- wrinkled bedding
- caps, such as those found on a prefilled saline syringe, left in the bed that the patient then lies on
- infection
- pain
- skin breakdown
- ingrown nail
- temperature changes
- medical procedures such as catheterization.

The symptoms associated with autonomic dysreflexia include:

- increased BP
- bradycardia
- anxiety
- headache
- sweating
- nasal stuffiness
- debilitating headache
- flushing to the skin above the injury
- piloerection
- blurred vision.

patients may require a feeding tube. Additionally, the patient's nutritional status should be monitored closely.

The outcomes for patients with an SCI are improved when they're transferred to specialized centers. Physical therapy (PT) and occupational therapy (OT) also play an essential role. Participating in PT can help prevent muscle atrophy and contractures. OT may be helpful to teach the patient new ways of completing tasks.

Over time, patients with an SCI may be able to live a fairly independent life. They may be able to drive, play sports, and have intimate relationships, to name a few. However, this independence won't happen overnight and may be delayed due to feelings of sadness, grief, anger, and dissatisfaction with body image. Be aware that these feelings can affect the patient's psychosocial well-being and quality of life. Body changes such as weight gain, often in the abdominal area, and muscle atrophy can increase the risk of negative body image. Research has suggested that patients with an SCI will have a gradual adjustment to these changes and develop acceptance.

Negative feelings can be prevented or treated by ensuring that the patient has others to talk with about feelings, such as a mental health professional, social worker, and/or other individuals with an SCI. Although a negative body image may be experienced by patients with an SCI, appropriate treatment and care can help these individuals develop a positive body image. When caring for these patients, recognize that that they can benefit from talking with a social worker who has experience working with patients with an SCI.

Prevention

Knowing that most SCIs are caused by some type of preventable trauma, prevention through education, safety legislation, and technology is key.

Motor vehicle crashes account for 39% of SCIs. An example of effective safety legislation and technology regarding vehicle safety is the implementation of airbags and seatbelt laws, which have both decreased SCI. In some states, legislation has been put into place that makes texting or talking on the phone while driving illegal. Attention also needs to be paid to driving under the influence (DUI). Another important factor to consider when it comes to vehicle safety is the use of safety seats; children should be properly restrained in the car. Educate patients about the avoidance of distractions when driving, such as texting, talking on the phone, or eating, and provide education and outreach about DUI and car seat safety.

Falls are another common cause of SCI. Fall prevention education and strategies include removing throw rugs in the home, ensuring that floors and walkways are clear and stairways are well lit, clearing all walkways, using a night light at night, and using assistive devices. Additionally, nurses should implement appropriate fall prevention strategies in the healthcare setting.

Gun safety and swim safety are also important when it comes to the prevention of SCI. Children should be taught to never play with guns. Additionally, gun owners should be educated about keeping guns locked and stored out of reach. People should be taught not to dive in shallow sections of pools or into bodies of water that are shallow or hard to see to the bottom. Playgrounds should be well maintained and children should be supervised when playing on the playground. Caution should be used with trampolines and all appropriate safety precautions followed. Lastly, children should use properly fitting protective gear when playing sports.

For the best outcome

Nurses play an important role in helping patients with an SCI develop self-esteem, happiness, determination, freedom, and a sense of usefulness. The nurse can also help develop SCI prevention programs and take part in legislation and crafting

policies and procedures. In many cases, viable axons are found around the injury, a promising finding that may lead to future therapy development. Nurses working with these patients should follow current research and keep abreast of changes as they develop to continue to improve patient care and outcomes. ■

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