BRAIN AND SPINAL CORD INJURIES

INTRODUCTION

Brain and spinal cord injuries are very common medical emergencies. Brain injuries associated with medical conditions are the third leading cause of death in the US and they are leading cause of disability. Most brain juries are a complication of widespread diseases such as atherosclerosis, diabetes, and hypertension and they usually happen to people over the age of 65. Traumatic brain injuries cause approximately 40% of all deaths from accidents and injuries, and each year approximately 52,000 people die from a traumatic brain injury. Spinal cord injuries are caused by trauma or accidents and most of the victims are young men. Both brain injuries and spinal cord injuries can be devastating. Many of the victims who suffer a brain injury or a spinal cord injury do not survive and many of those that do survive have serious, permanent disabilities.

OBJECTIVES

When the student has finished this module, he/she will be able to:

1. Identify the most common type of brain injury.
2. Identify the correct definition of stroke.
3. Identify the two types of stroke.
4. Identify risk factors for stroke.
5. Identify how a stroke causes brain damage.
6. Identify signs and symptoms of stroke.
7. Explain the acronym FAST
8. Identify the most important aspect of stroke care.
9. Identify the factor that determines severity of a spinal cord injury.
10. Explain the difference between TIA and stroke.

THE BRAIN AND THE SPINAL CORD

The **brain,** the **spinal cord** and the **peripheral nerves** are the three major components of the **nervous system**. The nervous system is the part of the body that controls everything we do. All of our *conscious* behavior and all of our *unconscious* behavior starts with, and is controlled by the nervous system. Although the brain and spinal cord work together, they each have their own special role.

The **brain** could be considered the command center of the body, and it is divided into different, specialized regions. Each region is involved with a particular aspect of functioning and behavior that we can control - speech, emotions, problem solving, voluntary movements such as walking, etc. There are also specialized regions that initiate and control all of the functions and behavior that are involuntary, such as body temperature, breathing, digestion, and heart beat.

These specific regions in the brain work by sending messages/commands to the organs and the body and receiving information and feedback from tissues and organs. For example, if you are running to catch a train your muscles are working harder and need

more oxygen. The muscles send this information to the cardiovascular center of the brain and respiratory center of the brain. The cardiovascular center sends a message to the heart to beat faster and a message to the blood vessels to dilate. The respiratory center sends out a message to the lungs to breathe faster and deeper. These messages result in more blood with more oxygen is delivered to the muscles, and the process is complete.

The **spinal cord** is a long body of nervous tissue that located inside the spine. It starts at the base of the brain and ends at the bottom of the spine near the buttocks. The spinal cord has two functions: it helps control some basic body functions, and it is also the major "power conductor" of the information that the brain sends and receives. All along the entire length of the spinal cord, there are **peripheral nerves.** These are long, thin strands of nervous tissue that are, in a sense, like electrical wires. These peripheral nerves travel to all of the organs, the heart, lungs, liver, kidneys, glands, etc., to receptors for pain, heat, cold, and to every other part of the body. Information and messages from the different areas of the brain travel through the spinal cord and the peripheral nerves to the organs and the body. And information and messages from the organs and the body travel back to the brain through the peripheral nerves and the spinal cord.

The brain controls all of our conscious and unconscious behavior and all of our voluntary and involuntary behavior. It receives messages from our external and internal environment - it's cold out, I'm hungry, my muscles need more oxygen, there's a big pothole in the street in front of me. And in response to these messages the brain sends out information and commands - start shivering and put on a coat if you are cold, get something to eat if you're are hungry, increase heart rate and the rate of breathing if you need more oxygen, step around the pothole.

If there is an injury to the brain and/or the spinal cord, this process is disrupted. Depending on the location of the injury, specific aspects of our behavior and our functioning will be affected. For example, in some cases of brain injury a person's speech will be affected but she/he will retain all of the basic voluntary and involuntary muscle functions. Injuries to other parts of the brain will affect someone's ability to swallow or to walk. And if someone suffers a severe injury to specific areas of the spinal column, that person will not be able to move the arms or legs. Brain and spinal cord injuries can have devastating consequences.

BRAIN INJURIES

There are two *basic* causes of brain injuries: trauma and medical conditions. Traumatic brain injuries are less common and will only be discussed briefly; this module will focus on brain injuries caused by complications caused by medical conditions.

TRAUMATIC BRAIN INJURIES

Traumatic brain injuries are caused by a violent force that is applied to the head. Motor vehicle accidents, accidents related to sports, firearms injuries, and falls are common causes of traumatic brain injury. The intensity of the trauma to the head causes damage to the brain, and it also causes bleeding and swelling. *Because the brain is enclosed inside the skull, the bleeding and the swelling cause pressure on the brain tissue.* If the

bleeding, swelling, pressure, and the physical damage caused by the trauma are severe and can't be treated, the brain will suffer permanent injury.

BRAIN INJURIES ASSOCIATED WITH MEDICAL CONDTIONS

Brain injuries associated with medical conditions are caused by cancers, cardiac arrest, cardiac arrhythmias, hemorrhage, infections, and thrombosis (commonly known as a blood clot). The most common brain injury - a stroke - is caused by hemorrhage or a thrombosis, and a discussion of stroke will be the primary focus of this section. Brain injury from cancers, cardiac arrest, cardiac arrhythmias, and infections will be briefly discussed. There is also another neurological accident that is very similar to stroke, transient ischemic attack (TIA), and this will be discussed, as well.

Stroke

The most common type of brain injury is a stroke. Strokes are one of the leading causes of death in the US, they are *the* leading cause of disability, and each year approximately 700,000 people in the US have a stroke. The survival rate after a stroke has improved with better treatment, improved emergency care, and increased public awareness. But stroke is still a huge public health problem, and a stroke is a medical emergency.

The technical term for a stroke is cerebrovascular accident or CVA. The word vascular means of or pertaining to the blood vessels and circulation. The prefix cerebro means of or pertaining to the brain. The two together provide the basic definition of a stroke/CVA.

A stroke is defined as a sudden disruption of the blood supply to the brain that may cause permanent damage.

There are two types of stroke, ischemic stroke and hemorrhagic stroke.

- Ischemic stroke: Ischemia is a medical term that means decreased blood supply to a specific area. An ischemic stroke happens when the blood flow to the brain is interrupted by a blood clot. There are two causes of ischemic stroke. The first is atherosclerosis, commonly called hardening of the arteries. Atherosclerosis is a very common cardiovascular disease. Atherosclerosis causes deposits of cholesterol and fat to build up in the walls of the arteries and veins. These cholesterol and fat plaques interfere with blood flow, and they also provide a place for blood clots to form. These blood clots are called a thrombosis. If the cholesterol and fat plaques and the blood clots inside the arteries and veins become too large, blood flow can be severely decreased or completely stopped, and an ischemic stroke can happen. The second cause of ischemic stroke is an embolism. An embolism is a thrombosis that has broken off from an artery or a vein. The embolism moves through the circulation and becomes lodged in a blood vessel in the brain, stopping the blood flow and causing ischemic damage. Ischemic strokes are more common than hemorrhagic strokes: approximately 80% of all strokes are ischemic strokes. Ischemic stroke is also a common

complication of atrial fibrillation (a very common cardiac arrhythmia), diabetes and hypertension.

- Hemorrhagic stroke: A hemorrhagic stroke happens when a blood vessel in the brain ruptures. This causes damage in two ways. First, the brain does not receive oxygenated blood. Second, because the brain is enclosed in the skull, the blood that leaks from a ruptured artery or vein has nowhere to go and the buildup of blood in this enclosed space causes pressure on the brain tissue. Hemorrhagic strokes are usually a complication of chronic hypertension. The signs and symptoms of hemorrhagic stroke are essentially the same as those of an ischemic stroke, but hemorrhagic strokes are usually more severe. People who are 45 years of age or younger who have a stroke are more likely to have a hemorrhagic stroke.

Learning Break: Most strokes are ischemic or hemorrhagic. But a small percentage of strokes can be due to illicit drug abuse, migraine headaches, or a sudden spasm of a blood vessel. And in some cases, the cause of the stroke cannot be found.

Why is a stroke a medical emergency? Why can a stroke cause such serious neurological damage? The simplest answer is supply and demand. All of the tissues and organs of our body need oxygen to survive. Oxygen is carried by the blood, and the brain, heart, kidneys, muscles, and other organs all receive the amount they need. Without oxygen, these organs and tissues will die.

But the brain is especially sensitive to a lack of oxygen. The brain accounts for only 2% of total body weight. But the brain needs about 15-20% of all the blood that is pumped by the heart each minute. Brain tissue is very active and it needs a big supply of nutrients and oxygen. If the blood flow to the brain is restricted or stopped, the consequences can be very severe. The brain can tolerate <u>very</u> short interruptions in blood flow, but after 3 minutes without oxygen serious irreversible brain damage is likely to occur.

Risk Factors for Stroke

Stroke is more common among men and more common in African-Americans. The older someone is, the greater the risk that he/she will have a stroke, and most strokes happen to people who are 65 years of age or older.

The <u>controllable</u> risk factors for stroke are atherosclerosis, certain heart arrhythmias (especially atrial fibrillation), cigarette smoking, diabetes, hypertension, obesity, and a sedentary life style.

The <u>uncontrollable</u> risk factors for stroke are age, gender, ethnicity, a family history of stroke, and a previous TIA. Age increases the risk for stroke because older people have more, and more serious medical problems that are associated with stroke. It is not clear why women are more likely to suffer a stroke; it may simply be because women live longer. The ethnic risk factor for stroke has been intensely debated. It is still not clear if the ethnic risk factor is related to ethnicity itself or health and lifestyle issues. A family history of stroke is also difficult to understand, and the contribution of genetics to stroke is not clearly understood.

Learning Break: Atrial fibrillation is a very common cardiac arrhythmia. Atrial fibrillation disrupts the normal rhythmic contractions of the atria. Instead of beating in a regular, synchronized manner, the atria beat very fast and erratically - they quiver, or fibrillate. Because of this, blood pools in the atria and clots are formed on the atrial walls. Pieces of the clots - embolisms – occasionally break off, travel through the circulation and can occlude a blood vessel in the brain.

Signs and Symptoms of a Stroke

The signs and symptoms of a stroke depend on what part of the brain is affected and how much damage has been done. They may include:

- Weakness in one side of the body
- Differing degrees of paralysis
- Facial droop
- Decreased level of consciousness
- Loss of consciousness
- Confusion
- Inability to speak and/or inability to understand speech
- Sudden vision loss
- Dizziness
- Loss of balance
- Sudden and severe headache

A quick way to determine if someone is having a stroke is to use the acronym **FAST**. Look at the victim's **F**ace to see if one side is drooping. Ask the victim to hold up his/her **A**rms and see if one or both drifts down. Check and see if the victim's **S**peech is slurred. The **T** stands for **T**ime: Time is critical because the sooner someone receives medical treatment the better chance that person has for recovery.

FACE → **A**RMS → **S**PEECH → **T**IME

The signs and symptoms of a stroke can be dramatic: the victim may be confused, lose consciousness, or complain of a severe headache. But the signs and symptoms can be mild and subtle, as well. Someone having a stroke may simply "not feel right," complain of dizziness, weakness, or some blurred vision. A severe stroke is usually very obvious,

but a mild stroke or one that is just beginning may be hard to detect. In the latter situation an exam by a physician and specific diagnostic tests are needed to know if that person is, or is not having a stroke. If there is *any* suspicion someone is having a stroke, call 911. Be *especially* cautious if someone has risk factors for stroke.

Some people who suffer a stroke do recover, but the recovery process is difficult. The survivors often develop complication such as bed sores, depression, pneumonia, and thrombosis. And recovery is not a guarantee of a healthy life. Approximately 20% of all stroke victims die within the first year. Permanent disabilities are common and very serious. These permanent disabilities caused by a stroke include:

- Aphasia: Aphasia means the inability to speak. Aphasia is a common complication of stroke.

- Coma

- Paralysis: Paralysis that is caused by a stroke can affect one part of the body (e.g., part of the face or one arm), or it may affect one half or one side of the body. Paralysis of one side of the body (face, trunk, arm, and leg) is called hemiplegia. Paralysis affecting the lower half of the body is called paraplegia. Paralysis affecting the upper and the lower extremities is called quadriplegia.

- Visual deficits.

- Weakness: The stroke victim may not suffer from paralysis, but the stroke may cause serious muscle weakness. Muscle weakness caused by a stroke that affects one side of the body is called hemiparesis. Muscle weakness that affects the lower extremities is called paraparesis. Muscle weakness that affects the upper and lower extremities is called quadriparesis.

Treatment of a Stroke

There are two basic aspects of treatment of a stroke: immediate medical care and rehabilitation.

The immediate medical care of a stroke is critically important: someone who is having a stroke needs evaluation and treatment as soon as possible. Prompt medical attention is *the* most important part of stroke care. If you suspect that someone is having a stroke, call 911 immediately.

However, the patient may not realize he/she is having a stroke: the signs and symptoms may be mistaken for another illness, or the signs and symptoms may be relatively mild and subtle. Some patients may deny the seriousness of the effects, or they may simply wait, hoping that the signs and symptoms will go away. Regardless of why, a significant number of people who are having a stroke arrive at the hospital many, many hours after the stroke has begun, and this is the worst possible scenario. Successful treatment of a stroke requires prompt medical care.

Why is prompt treatment of a stroke so important? Brain cells that are deprived of oxygen will die very quickly. Remember, after three minutes without oxygen irreversible brain damage will occur. But when someone is suffering a stroke, some parts of the brain will be injured *but will not be permanently damaged if treatment is delivered quickly enough*. Medical personnel who care for stroke victims often say, "Time is brain," and that is very true. The brain tissue that is dead cannot be saved, but the injured areas *can* be restored if treatment is delivered in a timely manner. This is especially true if the patient is having an ischemic stroke.

Ischemic strokes are treated with IV medications that break up the clot that is causing the stroke; these drugs are called thrombolytics. Thrombolytics are usually given in an emergency room, but in some circumstances they may be given by emergency medical services (EMS) personnel on the scene or while en-route to a hospital. The goal is to deliver the thrombolytics within three hours of the onset of the signs and symptoms of an ischemic stroke: Time is brain. If the thrombolytics are given within the three hour window, injured brain tissue can be restored and the patient will be less likely to suffer permanent neurological damage.

A hemorrhagic stroke is treated with anti-hypertensives to lower blood pressure and with surgical and medical procedures that decrease the pressure on the brain. These patients need prompt treatment, as well, and for the same reason discussed in the section on ischemic stroke: Time is brain. Hemorrhagic strokes would <u>not</u> be treated with thrombolytics. Thrombolytics are blood thinners that prevent the blood from coagulating. If they were given to someone who is bleeding from a hemorrhagic stroke the damage could be catastrophic.

Once a stroke has occurred, and after the initial medical and/or surgical treatment has been delivered, the patient who has had a stroke needs rehabilitation. Rehabilitation for a stroke victim is similar to the immediate medical care: it must be done promptly and the sooner it is started the better the recovery is likely to be.

The rehabilitation starts with an assessment of the patient's neurological and physical capabilities.

- Can the patient speak?
- Can the patient understand speech?
- Is the patient oriented to time, place, and person?
- How much physical ability does the patient have? Is he/she paralyzed, or does he/she have significant muscle weaknesses? Is the patient able to swallow? Many patients who have had a stroke have damage to the gag reflex and they cannot eat solid food.

If these disabilities are present they may, with time and rehabilitation, improve or even completely resolve. Recovery from a stroke happens in two phases. There is recovery that happens in the first 3-6 months after a stroke: this accounts for most of the recovery that is going to occur. There is also recovery that happens in the following months and years.

Rehabilitation will also include monitoring for, and treating the various post-stroke complications that can occur.

It can be very difficult to predict how much function a stroke victim will regain. But if the damage has been very severe and the patient does not recover any function within the first few months, the outlook is very poor. However, studies have shown that when the amount of damage is compared to the degree of recovery, patients who undergo extensive rehabilitation do far better than would be expected. Rehabilitation does work, and the sooner it is started the better.

Post-Stroke Complications

Complications after a stroke are very common. These can involve essentially every organ system.

Aspiration can be a serious problem after a stroke. Loss of the gag reflex is common this puts the patient at risk for aspiration and pneumonia. Dysphagia, a common complication of stroke, contributes to the risk of aspiration. Aspiration is more likely to occur if the patient is > 65 and/or has had a severe stroke.

Major depression is very common after a stroke. The psychological burden of depression is significant, but depression is also physical risk for the patient. It is not clear why, but patients who develop depression after a stroke are more likely to suffer from other complications and they are more likely to die from the stroke.

Many patients who have had stroke will be immobile for some period of time, and deep-vein thrombosis (DVT) and pulmonary embolism (PE) are likely to occur. A DVT or a PE can significantly increase the risk of death, and they can also prolong hospital stay and recovery time. Fortunately, DVT and PE can be prevented with the use of anti-coagulant drugs. Immobility also puts patients at risk for contractures, skin breakdown, and pressure ulcers.

Both fecal incontinence and urinary incontinence are also common complications of a stroke.

Stroke and spinal cord injuries increase the risk of developing infections such as urinary tract infections and respiratory infections.

SPINAL CORD INJURIES

Spinal cord injuries are almost always caused by a traumatic injury from an automobile accident, a fall, a firearm, or a sports accident such as a collision in football. Spinal cord injuries are less common than brain injuries caused by trauma and they are less common than ischemic and hemorrhagic strokes. Spinal cord injuries can be relatively mild and the patient can recover, or they can be very severe and the patient will have a permanent disability.

The signs and symptoms of a spinal cord injury are very similar to those of a stroke, but they tend to be more extensive and more severe. Permanent disabilities are common, and people who have had a spinal cord injury can develop the same complications that are associated with a stroke.

In general, the outlook for spinal cord injuries is not good. The life expectancy of people who have had a serious spinal cord injury and who survive the initial injury is significantly decreased. Approximately 10-20% of these patients die before reaching a

hospital. And if the patient is completely paralyzed and he/she does not regain *any* function within 72 hours of the accident, that patient will never recover voluntary movement. Many people who survive the initial accident die from complications such as pneumonia, other infections, or pulmonary emboli (blood clots in the lung).

The location of the spinal cord injury is the factor that determines how disabled someone will be. The spinal cord is located inside the spine, and the spine is divided into four separate areas that start at the neck and extend to the buttocks: cervical, thoracic, lumbar, and sacral. The area of the spine in the neck is called the cervical spine. The most serious spinal cord injuries happen when the spinal cord in the area of the cervical spine or the thoracic spine is damaged. The closer to the skull, the worse the injury is likely to be, and damage to the spinal cord in the area of the cervical spine (commonly called C-spine injuries) often causes severe and permanent damage.

Treatment of Spinal Cord Injuries

Treatment of spinal cord injuries is the same as for a stroke: immediate medical care and then rehabilitation. Unfortunately, spinal cord injuries cannot be treated as successfully as can a stroke. In most cases, once the spinal cord is damaged there is no way to repair it. Patients who have suffered a spinal cord injury usually have very serious, permanent disabilities. If paralysis is still present 72 hours after the spinal cord injury, there is no chance for recovery. Less severe injuries may not result in permanent disabilities, but the prognosis is still poor. The complications associated with a spinal cord injury are the same as those associated with a stroke. However, because the damage from a spinal cord injury is often severe and irreversible, aspiration, incontinence and the other physical complications are problems that will not go resolve with time.

Learning Break: Some patients who have a spinal cord injury may benefit from high-dose steroid therapy with drugs such as methylprednisilone. Using high-dose steroid therapy was once routine treatment for spinal cord injuries, but in recent years the effectiveness of this therapy has been questioned. It is still used, but not as often and more selectively.

TRANSIENT ISCHEMIC ATTACK

A transient ischemic attack (TIA) is defined as a sudden episode of neurological dysfunction that does not cause permanent damage. A TIA is very similar to a stroke: it is caused by an interruption in blood flow to the brain, and the patients have many of the same signs and symptoms as do stroke patients. The causes of TIA and the factors that increase the risk of having a TIA are essentially the same as those of a stroke, except that women are less likely than men to have a TIA.

The informal term for a TIA is a “mini-stroke” and as noted above, there are similarities of a TIA to a stroke. However, there are two primary differences between a TIA and stroke that are important to know.

In a TIA, the flow of blood is spontaneously restored and brain tissue is not damaged.

So, a patient having a TIA will have many of the same signs and symptoms as will someone having a stroke, but the clinical presentation is usually less severe and the brain tissue will not be permanently damaged.

A TIA, however, is still a serious medical problem, and TIAs are very common.. Approximately 20-30% of all people who have a TIA will have a stroke, and the stroke will happen 7 days or so after the TIA. Anyone who is having, or is suspected of having a TIA should be immediately transported to an emergency room.

Treatment of a TIA

The primary goals when treating a patient who is having a TIA are: 1) make sure the patient is not having a stroke; 2) treat the medical conditions that are causing the TIA, and; 3) start therapies that will prevent the patient from having a stroke.

A computerized axial tomography (CAT) scan or a magnetic resonance imaging (MRI) scan, or some other type of imaging study should be done. This will determine if the patient is having a TIA or a stroke. The basic causes of the TIA such as atherosclerosis or hypertension will be treated, and some type of anti-coagulant therapy will be started to prevent a stroke.

CANCERS, CARDIAC ARREST, CARDIAC ARRHYTHMIAS, AND INFECTIONS

Cancers, cardiac arrest, cardiac arrhythmias, and infections can all cause damage to the brain and the spinal cord. Cancers and infections are not acute problems. These diseases tend to develop slowly, and the damage they cause to the brain and spinal cord is not sudden and dramatic. Cardiac arrest and cardiac arrhythmias such as ventricular tachycardia and ventricular fibrillation cause brain injury by an abrupt disruption of circulation. In these situations, the heart stops pumping or the pumping action of the heart is too weak and uncoordinated to deliver blood to the brain.

THE BASICS OF CARE

Caring for a patient who has had a stroke or a spinal cord injury is very involved. The basics of care should that a CNA should particularly focus on include the following:

- Aspiration: The physician or a therapist will prescribe specific aspiration prevention techniques such as elevation of the head while eating, swallowing exercises, etc. The CNA must be aware that the signs of aspiration can be subtle, so any symptoms or unusual behaviors that seem to be associated with eating should be reported.

- Nutrition: Adequate nutrition and good hydration are essential for recovery. The CNA has a responsibility to monitor the patient’s food and fluid intake.

- Observe for complications: Know what complications are associated with stroke and spinal cord injuries, and make sure you observe the patient closely for their development.

- Skin care: Immobility, dehydration, incontinence, and pre-existing medical conditions such as diabetes are common in stroke and spinal cord injury patients. These increase the risk of developing skin breakdown and pressure ulcers, so the CNA must be very careful in the assessment and treatment of the patient's skin.