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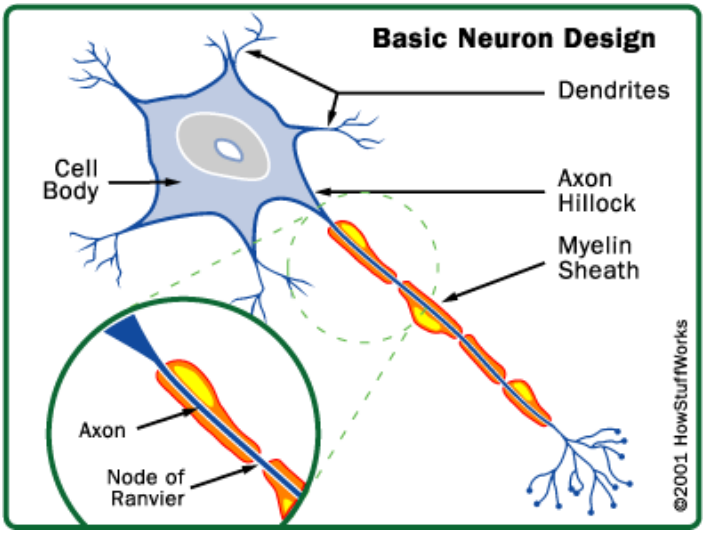
Pain: How it Moves Through the Body and the Importance of it

For humans, pain is one of a few constants in life. It is there during childhood, in adult life and especially in old age. Sometimes it alerts those who have done great harm to themselves, other times it is just a nuisance in everyday life, such as when a toe is stubbed. Because pain is a sensation that will always exist, humans have been trying to define the sensation of pain since the beginning of time. Dictionary.com gives a good starting point in defining it as "a distressing sensation in a particular part of the body." And though this definition is true, it is only a small part of what pain really is. Pain is the signal that neurons send to the brain that lets it know that damage has occurred somewhere in or on the body. Because pain is essential to survival, those with dysfunction in this process are in danger of bodily harm and preventable death.

What is pain exactly? Pain has been defined in many different ways. Harold Merskey gave the most accurate definition of pain. He described pain as "an unpleasant sensation and emotional experience associated with actual or potential tissue damage" (Minde). Pain is not only a sensation, but a learning mechanism as well. Those who experience a sensation of great pain tend not to repeat the actions that caused it. Along with this each individual has their own perception of pain. For those who have fractured bones, their opinion of excruciating pain is much higher than those who have never fractured a bone in their lives. For those who have not experienced pain before, it is harder for them to learn the same lessons that those with functioning pain sensations learn and to avoid situations that put their bodies in harm's way.



Before discussing disorders of pain and its affects, one must know how it moves through the nervous systems. Pain is created when pain nerve endings are stimulated, and the painful stimuli cause the release of chemicals that fit into special pain receptors in the pain neurons which causes them to activate. The axons of the pain neurons then carry the pain signals to the spinal cord, brain and near the skin to cause visible bruising and redness. Before the pain signals are carried to the brain, however, the spinal cord initiates involuntary movements, reflexes that remove the painful stimuli. To carry these pain signals two types of fibers are needed, A-delta fibers carry sharp pain sensations while C fibers carry dull aches and burning sensations. Although both kinds of pain signals come from the same place, each sensation follows different pathways to different regions of the brain. Different pain neurons are activated by different degrees of stimuli and many types of neurotransmitters are used by these different pain neurons (Bernstein).

Along with the natural way pain moves through the nervous system there are several theories that explain the modulation of pain in the nervous system. The most popular of these theories is the gate control theory which states that there is a “gate” in the spinal cord that either allows pain signals to travel upward to the brain or inhibits them from going any farther. The original gate control theory proved to be incorrect but after more research, later work supported the idea of natural mechanisms can block pain without the aid of medication (Bernstein). According to the gate control theory, signals from other skin senses, such as touch, can enter into

the spinal cord at the same time as the pain signals and take over the pathways to the brain that the pain signals would have used. This explains why rubbing a toe after it has been stubbed on a door way reduces the painful feeling. The brain is also capable of closing the gate by sending signals down the spinal cord. These signals coming from the brain block incoming pain signals at the synapses of the spinal cord. This causes an Analgesia which is the absence of the sensation of pain in the presence of normally painful stimuli (Bernstein). Other modulations of pain are the enkephalins and endorphins that the brain produces. Both are morphine like substances that affect the body in a different ways. Enkephalins have a short period of action and act mainly in the spinal cord where the block the transmission of pain signals. Endorphins on the other hand are found throughout the brain and are believed to control pain mainly at the brainstem. Like pain inhibiting drugs such as morphine, these substances combine with receptors that activate a pain inhibiting neural pathway that makes it way down the spinal cord. They are generally released in a time of acute stress and are believed to be responsible for the absence of that occurs sometimes with sports injuries (Chapman).

Not only does pain have physical aspects that affect it but psychological ones as well. Usually because intense sensations of pain bring out unpleasant emotions and the injured person shows not only awareness of tissue damage but emotional distress as well. In some cases emotional distress may either heighten or lower the level of pain, making it a major component of the experience (Chapman). Studies have shown that a patient's understanding of what has and will happen to them and the amount of threat they feel will all add to the intensity of the pain that they experience (Chapman). This is why in car accidents, the paramedics try to keep the patients as calm as possible so as not to cause them more pain than necessary.

Now let's review the normal functions of a pain neuron. The pain nerve endings are stimulated and the painful stimuli cause the release of chemicals fitting into special pain receptors in the pain neurons causing them to activate. The axons of the pain neurons then carry A-delta fiber and C fibers to the spinal cord and later the brain. Before the pain signals reach the brain, the spinal cord initiates involuntary movements, reflexes, to remove the painful stimuli. In dysfunctional pain neurons however, things work differently. Although the pain neuron may activate, the pain signals they send never reach the spinal cord or brain. This is caused by poor development of neurons at birth (Langone).

The dysfunction of neurons due to poor development of pain receptors in the neurons at birth fall under the category of Hereditary Sensory and Autonomic Neuropathy (HSAN). HSANs are "a group of rare and poorly characterized disorders associated with sensory and or autonomic nervous system deficits" (Minde). The types of HSAN are each different from one another and are caused by various gene mutations (Langone). Although each type is different HSANs have a set of general symptoms that often start in early childhood. Patients experience symptoms in the autonomic nervous system such as sweating and temperature disturbances, resulting in reoccurring fever and hypothermia. Other symptoms include skin blotching and mild to severe mental retardation (Minde).

In total there are five types of HSAN, all of which deal with symptoms in the sensory and or autonomic nervous systems. Type I, hereditary sensory radicular neuropathy, is the most common strain of HSAN. It is a sensory neuropathy that starts within the second to fourth decades of life with sensory loss and foot ulcers. Type I HSAN affects all modalities of sensation and in some cases reflexes in the Achilles tendon are severely reduced. Currently, the only-treatment for Type I is supportive therapy.

Type II, also known as congenital sensory neuropathy, starts in the earliest stage of life, infancy. In infancy symptoms start with multiple autonomic dysfunctions and impaired sensory functions which lead to tropic ulcers (Minde). Other initial symptoms include swallowing problems, self mutilation and delayed development. Visible features include dry skin and fractures (Langone). Like Type I, treatment for Type II only includes supportive therapy.

Type III, Familial Dysoutonomia, does not only deal with the loss of the sensation of pain but also with many other neuron dysfunctions. Familial Dysoutonomia is "a genetic disease present at birth in male and female Jewish babies, primarily causing dysfunction of the autonomic and sensory nervous systems. Dysfunction is a result of an incomplete development of the neurons of these systems" ("About"). Both the autonomic and sensory nervous systems are responsible for their own set of tasks. The autonomic nervous system controls overflow tears, breathing when there isn't enough oxygen, regulation of blood pressure, normal swallowing and safe responses to stress. The sensory nervous system regulates protective reactions to pain, perceptions of hot and cold and taste. Functions of both nervous systems are severely affected in the symptoms of FD. Symptoms displayed in babies include poor muscle tone, weak or absent suck, blotching skin and difficulty maintaining normal body temperature. Symptoms of an older child include poor balance, excessive drooling, poor weight gain, frequent lung infections, cold and puffy hands and feet and many others. One thing that sets FD apart from the other types of HSAN is that no child has the same symptoms and the severity of the symptoms is extremely variable. Also unlike the other types, treatment for FD includes more than supportive therapy. Because each case of FD is individualized, each patient has a specific treatment for their set of symptoms. The more common-treatments are artificial tears, special feeding techniques, special therapies, special drug management, respiratory care, protecting the child from injury and

treatment of orthopedic problems (“About”). Even though there is so much treatment available, approximately half of all patients with FD die before age thirty (Minde).

Type IV, congenital insensitivity to pain with anhidrosis, comes in second place as the rarest of the five types of HSAN. Congenital insensitivity to pain with anhidrosis (CIPA) is characterized by fever, anhidrosis, the inability to sweat, and lack of reaction to painful stimuli (Minde). The lack of reaction to painful stimuli refers to both superficial and deep pain, not being able to feel these may cause burn injuries, and many painless fractures. The main features of CIPA include a lack of pain sensation, painless injuries of the oral structures, fever during hot weather and infection and scarring of the tongue, lips and gums (Alabousi). The lack of pain sensation in CIPA patients is due to absence of unmyelinated fibers that carry pain signals to the spinal cord and brain. Anhidrosis is a result of a loss of innervations of eccrine sweat glands, which are responsible for the regulation of body temperature through sweat production (Alabousi). At this time there is no treatment other than supportive treatment for CIPA patients. One precaution they may choose is to live in colder climates, along with having multiple checkups throughout the day to make sure that no fractures or other injuries have been obtained recently.

Type V, congenital insensitivity to pain with partial anhidrosis, is the rarest of the five types of HSAN. Like CIPA, Type V has a selective loss of temperature and pain sensations but comes with normal functioning sweat glands and only a few other autonomic deficits (Minde). All patients tend to respond normally to touch, pressure and vibration. Even though those functions are normal they still have a selective loss of pain and temperature sensations. This can lead to painless fractures, bone necrosis and neuropathic joint destruction. Like CIPA as well, the only treatment available at this time is supportive therapy and patients also must have multiple

checkups throughout the day. Let's give an example of an everyday situation that a patient might encounter. A young girl at the age of seven, watches her mother as she curls her hair with two separate curling irons. Without realizing it the young girls places her hand on the metal part of the curling iron. Because she lacks temperature and pain sensations she does not feel how hot the metal is or the burning sensation in her fingers and doesn't understand that if she does not pull away the curling iron will burn her. By the time her mother sees this and removes the young girls hand it is too late, the damage has been done.

Most often pain is looked at from only one or two directions. It is seen as a physical feeling after harm has been brought upon the body, or an emotional feeling associated unpleasant events in a person's life. What pain really is, however, is a piece of information that is shared between the neurons, the spinal cord and the brain. Not only is this information useful but it is vital to the survival of human beings. Because of pain, people are able to do many things. Athletes know when to stop playing when they have been injured and a carpenter knows that his thumb is injured after a hammer has been brought down on it. For those with pain neuron dysfunction, life is a little more difficult. Because of the lack of pain sensations patients cannot tell when something is wrong on or within the body. Sometimes it can be a non-lethal injury, but other times it is an injury that if gone untreated can lead to death. Pain is not just a feeling that humans have to deal with on a day-to-day basis, but the body's alarm system and an essential part of what is keeping us alive.

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