ADDITIONAL RESOURCES

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http://www.ccnm.edu *Canadian College of Naturopathic Medicine/Robert Schad Naturopathic Clinic*
http://www.health.harvard.edu *Harvard Health Publications*

CHAPTER 4

Pain

CHAPTER OUTLINE

LEARNING OBJECTIVES

After studying this chapter, the student is expected to:

1. State the causes of pain.
2. Describe the pain pathway.
3. Relate the methods of pain control to the gate-control theory.
4. Discuss the signs and symptoms of pain in adults and young children.
5. Compare referred and phantom pain.
6. Explain the factors that may alter pain perception.
7. Compare acute and chronic pain.
8. Discuss the types of headache.
9. Describe methods of pain management.

KEY TERMS

afferent fibers
analgesic
bradykinin
cordotomy
dermatome
efferent
endogenous
histamine
intractable
ischemia
neurotransmitter
nociceptors
opioids
parenterally
prostaglandin
reticular activating system (RAS)
reticular formation
rhizotomy
sedatives
substance P
tachycardia

Pain is an unpleasant sensation, a feeling of discomfort resulting from stimulation of pain receptors in the body when tissue damage occurs or is about to occur. Pain is a body *defense* mechanism and is a warning of a problem, particularly when it is acute. It is difficult to define because it can have many variable characteristics, and it is a subjective feeling, impossible to accurately measure. However, subjective scales have been developed to facilitate comparison of pain levels over time. In cases of trauma, the danger may be obvious, but in other situations the cause may be hidden deep inside the body. Pain involves very complex mechanisms, many of which are not totally understood by scientists or health care workers.

Etiology and Sources of Pain

Pain stimuli may occur for many reasons. Pain may be felt because of inflammation, infection, **ischemia** and tissue necrosis, stretching of tissue, chemicals, or

burns. In skeletal muscle, pain may result from ischemia or hemorrhage. Many organs such as the liver, kidney, or brain are characterized by pain receptors in the covering capsule, and pain is felt when the capsule is stretched by inflammation. Stretching of tendons, ligaments, and joint capsules also elicits pain; these effects may occur secondary to inflammation or muscle spasm to guard a joint or painful body part. In the stomach and intestines, pain may result from inflammation of the mucosa, ischemia, distention, or muscle spasm.

Somatic pain may arise from the skin (cutaneous) or from deeper structures such as bone or muscle, to be conducted by sensory nerves. *Visceral pain* originates in the organs and travels by sympathetic fibers. Depending on the cause, pain may be sudden and short-term, marked primarily by a reflex withdrawal. For example, if one touches a hot object, the hand is involuntarily jerked away from the source of injury. Or pain may be relatively continuous, as when infection or swelling is present.

Structures and Pain Pathways

Pain receptors or **nociceptors** are free sensory nerve endings that are present in most tissues of the body (Fig. 4-1). These sensory nerves may be stimulated by thermal, chemical, or physical means. Thermal means refer to extremes of temperature, mechanical means could refer to pressure, and chemical sources could include acids or compounds produced in the body, such as **bradykinin**, **histamine**, or **prostaglandin**.

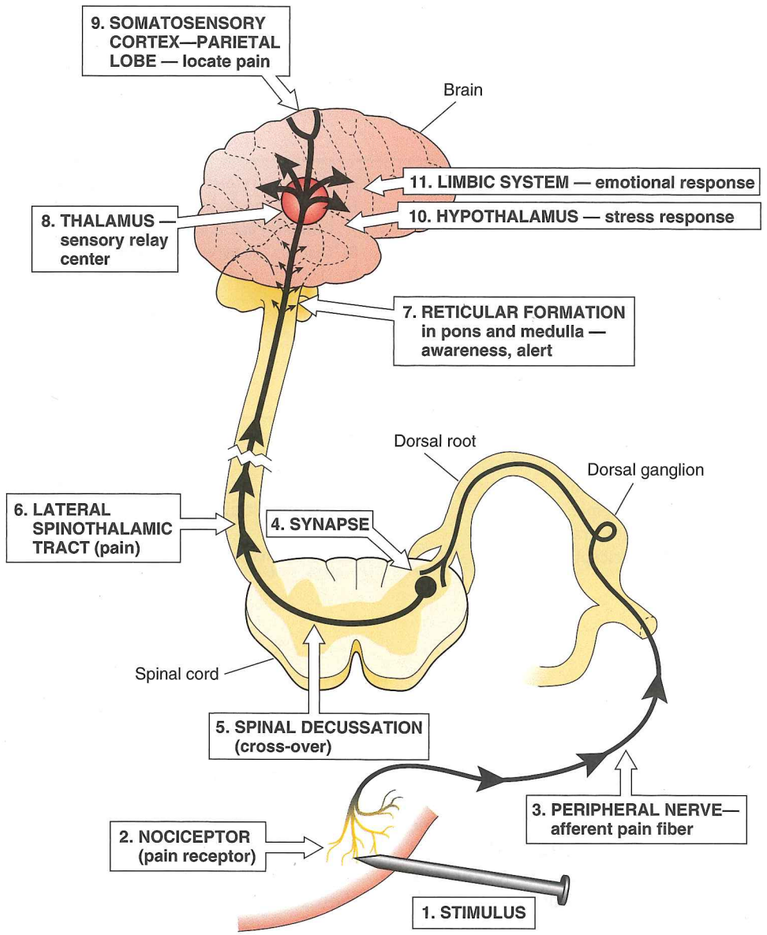

FIGURE 4-1 Pain pathway.

The *pain threshold* refers to the level of stimulation required to activate the nerve ending sufficiently for the individual to perceive pain. The associated nerve fibers then transmit the pain signal to the spinal cord and brain. The pain threshold is relatively constant over time and between individuals. The ability to withstand pain or the perception of its intensity is referred to as *pain tolerance*; this varies considerably with past pain experience and overall state of health.

Two types of **afferent fibers** conduct pain impulses: The myelinated A delta fibers that transmit impulses very rapidly and the unmyelinated C fibers that transmit impulses slowly. Acute pain—the sudden, sharp, localized pain related to thermal and physical stimuli primarily from skin and mucous membranes—is transmitted by the A delta fibers, whereas chronic pain—often experienced as a diffuse, dull, burning or aching sensation—is transmitted by C fibers. C fibers receive thermal, physical, and chemical stimuli from muscle, tendons, the myocardium, and the digestive tract as well as from the skin. The peripheral nerves transmit the afferent pain impulse to the dorsal root ganglia and then into the spinal cord through the dorsal horn or substantia gelatinosa (see Chapter 14).

Each spinal nerve conducts impulses from a specific area of the skin called a **dermatome** (see Fig. 14-22, which illustrates the areas of the skin innervated by each spinal nerve), and the somatosensory cortex is "mapped" to correspond to areas of the body so that the source of the pain can be interpreted in the brain (see Fig. 14-3 for a map of the brain). The dermatomes can be used to test for areas of sensory loss or pain sensation and thus determine the site of damage after spinal cord injuries.

At the spinal cord synapse, a *reflex response* to sudden pain results in a motor, or **efferent**, impulse back to the muscles that initiates an involuntary muscle contraction to move the body away from the source of pain. After the sensory impulse reaches the synapse, connecting neurons also transmit it across the spinal cord to the ascending tracts to the brain. There are two types of tracts in the spinothalamic bundle: The fast impulses for acute sharp pain travel in the neospinothalamic tract, whereas the slower impulses for chronic or dull pain use the paleospinothalamic tract. This double pathway explains the two stages of pain one often experiences with an injury to the skin, the initial sharp severe pain, followed by a duller but persistent throbbing or aching pain. These tracts connect with the **reticular formation** in the brain stem, hypothalamus, thalamus, and other structures as they ascend to the somatic sensory area in the cerebral cortex of the parietal lobe of the brain. It is here that the location and characteristics of the pain are perceived. The many branching connections from the ascending tracts provide information to other parts of the brain, forming the basis for an integrated response to pain.

THINK ABOUT 4-1

Trace the pathway of a pain impulse originating from stubbed toe by drawing a simple diagram and labeling the parts.

The arousal state of the **reticular activating system (RAS)** in the reticular formation in the pons and medulla influences the brain's awareness of the incoming pain stimuli. In clinical practice, many drugs depress the RAS, thereby decreasing the pain experienced. The hypothalamus plays a role in the response to pain through its connections with the pituitary gland and sympathetic nervous system. Response to pain usually involves a stress response (see Chapter 26) as well as an emotional response such as crying, moaning, or anger. There may be a physical response, perhaps rigidity, splinting, or guarding of an area of the body. The thalamus processes many types of sensory stimuli as they enter the brain and is important in the emotional response to pain through the limbic system.

THINK ABOUT 4-2

a. Describe your response to a sudden severe pain in your own experience; for example, an injury. Describe your physical response and your emotional reactions.
b. Using your knowledge of normal physiology, list the effects of increased sympathetic nervous system stimulation on body function and muscle tone.
c. Suggest how monitoring for sympathetic nervous system changes assists you in evaluating a person's level of pain.

Physiology of Pain and Pain Control

Pain is a highly complex phenomenon that is not fully understood. There are many variables in its source and perception and in the response to it in a specific individual. The *gate-control theory* has been modified as the complexity of pain is better realized, but the simple model serves as a useful tool and visual explanation of pain pathways that can be related to many concepts of pain and pain control. According to this theory, control systems, or "gates," are built into the normal pain pathways in the body that can modify the entry of pain stimuli into the spinal cord and brain. These gates at the nerve synapses in the spinal cord and brain can be *open*, thus permitting the pain impulses to pass from the peripheral nerves to the spinothalamic tract and ascend to the brain (Fig. 4-2). Or they may be *closed*, reducing or modifying the passage of pain impulses. Gate closure can occur in response to other sensory stimuli along competing nerve pathways that may diminish the pain sensations or by modulating or inhibitory impulses

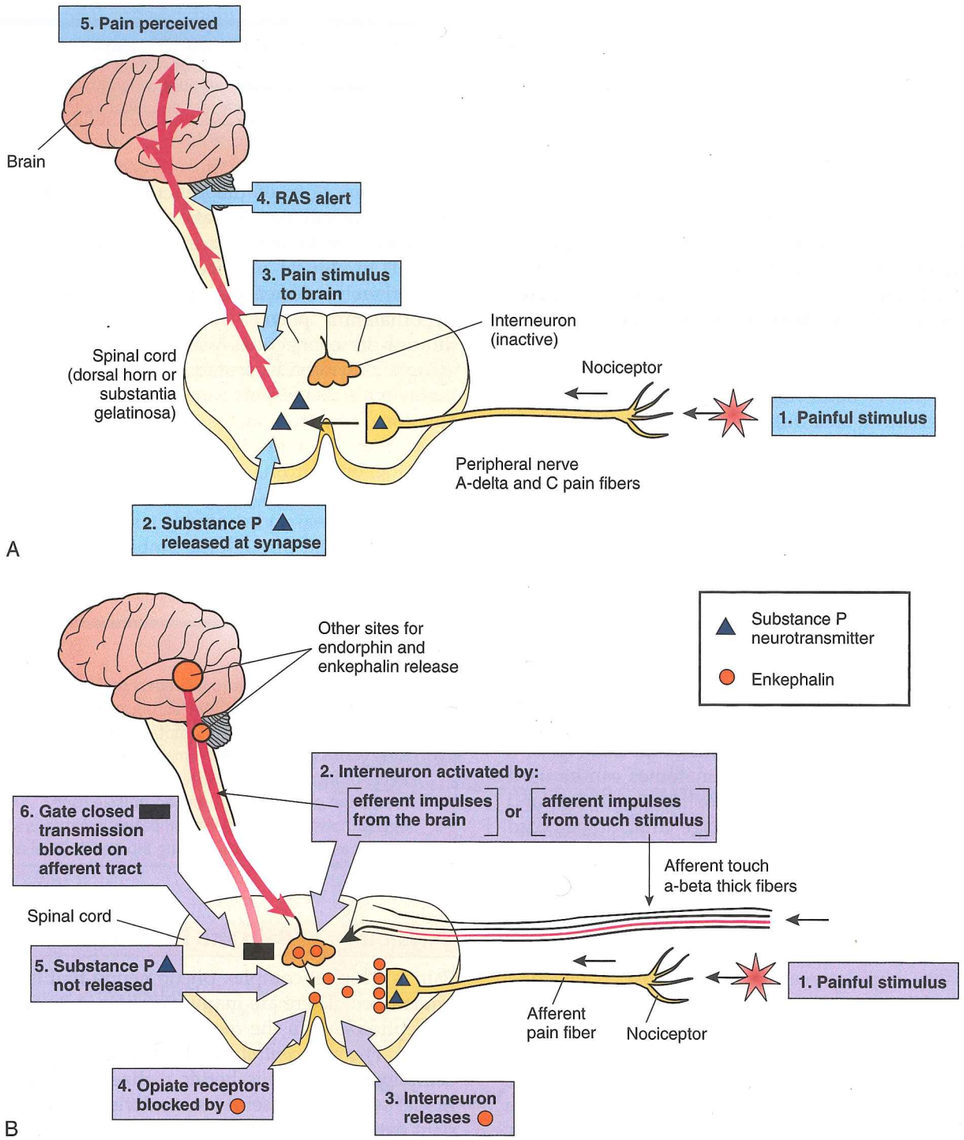

FIGURE 4-2 Pain control. **A**, Gate open—pain stimulus transmitted. **B**, Gate closed—pain stimulus blocked.

from higher centers in the brain. For example, application of ice to a painful site may reduce pain because one is more aware of the cold than the pain. Transcutaneous electrical nerve stimulation (TENS) is a therapeutic intervention that increases sensory stimulation at a site, thus blocking pain transmission. Alternatively, the brain can inhibit or modify incoming pain stimuli by producing efferent or outgoing transmissions through the reticular formation. Many factors can activate this built-in control system, including prior conditioning, the emotional state of the affected person, or distraction by other events. This last phenomenon has been observed in many individuals who feel no pain when injured suddenly but do experience delayed onset of pain once they are no longer distracted by the immediate emergency situation.

APPLY YOUR KNOWLEDGE 4-1

1. Predict several factors that could reduce pain tolerance and make pain more severe.
2. Suggest methods that might be used to distract a patient and reduce pain.

The key to this analgesia system, or the blocking of pain impulses to the brain, is the release of a number of opiate-like chemicals (**opioids**) secreted by interneurons within the central nervous system. These substances block the conduction of pain impulses into the central nervous system. They resemble the drug morphine, which is derived from opium and is used as an **analgesic**, and are therefore called *endorphins* or **endogenous** morphine. Endorphins include enkephalins, dynorphins, and beta-lipotropins. Figure 4-2 illustrates how enkephalin is released in the spinal cord and is attached to opiate receptors on the afferent neuron, thus blocking release of the **neurotransmitter substance P** at the synapse. This process prevents transmission of the pain stimulus into the spinal cord. *Serotonin* is another chemical released in the spinal cord that acts on other neurons in the spinal cord to increase the release of enkephalins. Clients with clinical depression often report chronic pain due to reduction in serotonin levels in the brain. In addition, natural *opiate receptors* are found in many areas of the brain, as are secretions of endorphins, which can block pain impulses at that level. The body has its own endogenous analgesic or pain control system that explains some of the variables in pain perception and can be used to assist in pain control.

THINK ABOUT 4-3

Briefly describe three methods of "closing the gate" and reducing pain.

Characteristics of Pain

Signs and Symptoms

Pain is a real sensation but a subjective symptom perceived by each individual. There are many variations in the clinical picture of pain as well as the verbal reports of pain.

Possible details that may be helpful in diagnosing the severity and cause of pain include:

- The location of the pain
- The use of many descriptive terms, such as aching, burning, sharp, throbbing, widespread, cramping, constant, periodic, unbearable, or moderate
- The timing of the pain or its association with an activity such as food intake or movement, or with pressure applied at the site
- Physical evidence of pain, when the patient may demonstrate a stress response with physical signs such as pallor and sweating, high blood pressure, or **tachycardia**
- Nausea and vomiting or fainting and dizziness, which may occur with acute pain
- Anxiety and fear, which are frequently evident in people with chest pain but may be present in other situations as well
- Clenched fists or rigid faces; restless or constant motion, or lack of movement; often protecting, or "guarding" the affected area

Young Children and Pain

For many years it was thought that newborn infants, because of their immature nervous systems, did not perceive or experience pain. It has now been established that a young infant does perceive pain and responds to it physiologically, with tachycardia and increased blood pressure as well as characteristic facial expressions. Infants with their eyes tightly closed, their eyebrows low and drawn together, and their mouths open and square are probably in pain.

There is great variation in the developmental stages and coping mechanisms of children. A range of behavior that may not accurately reflect the severity of pain should be expected. Older children may flail their legs and arms and resist comfort measures, or they may become physically rigid. Children may find it difficult to describe their pain verbally. However, drawings of happy or sad faces, mechanical scales, or multicolored symbols can be used by children to better describe their feelings. Withdrawal and lack of communication are often the result of pain in older children and teens.

Referred Pain

Sometimes the source of a pain stimulus can be localized to a specific area. In other cases the pain is generalized, and the source is difficult to determine. Sometimes the pain is perceived at a site distant from the source. This is called *referred* pain. Generalized and referred pains are characteristic of visceral damage in the abdominal organs. In some conditions, such as acute appendicitis, the characteristics of the pain may change as pathologic changes occur.

Referred pain occurs when the sensations of pain are identified in an area some distance from the actual source (Fig. 4-3). Usually the pain originates in a deep organ or muscle and is perceived on the surface of the body in a different area. For example, pain in the left neck and arm is characteristic of a heart attack or ischemia in the heart. Pain in the shoulder may be due to stretching of the diaphragm. Multiple sensory fibers from different sources connecting at a single level of the

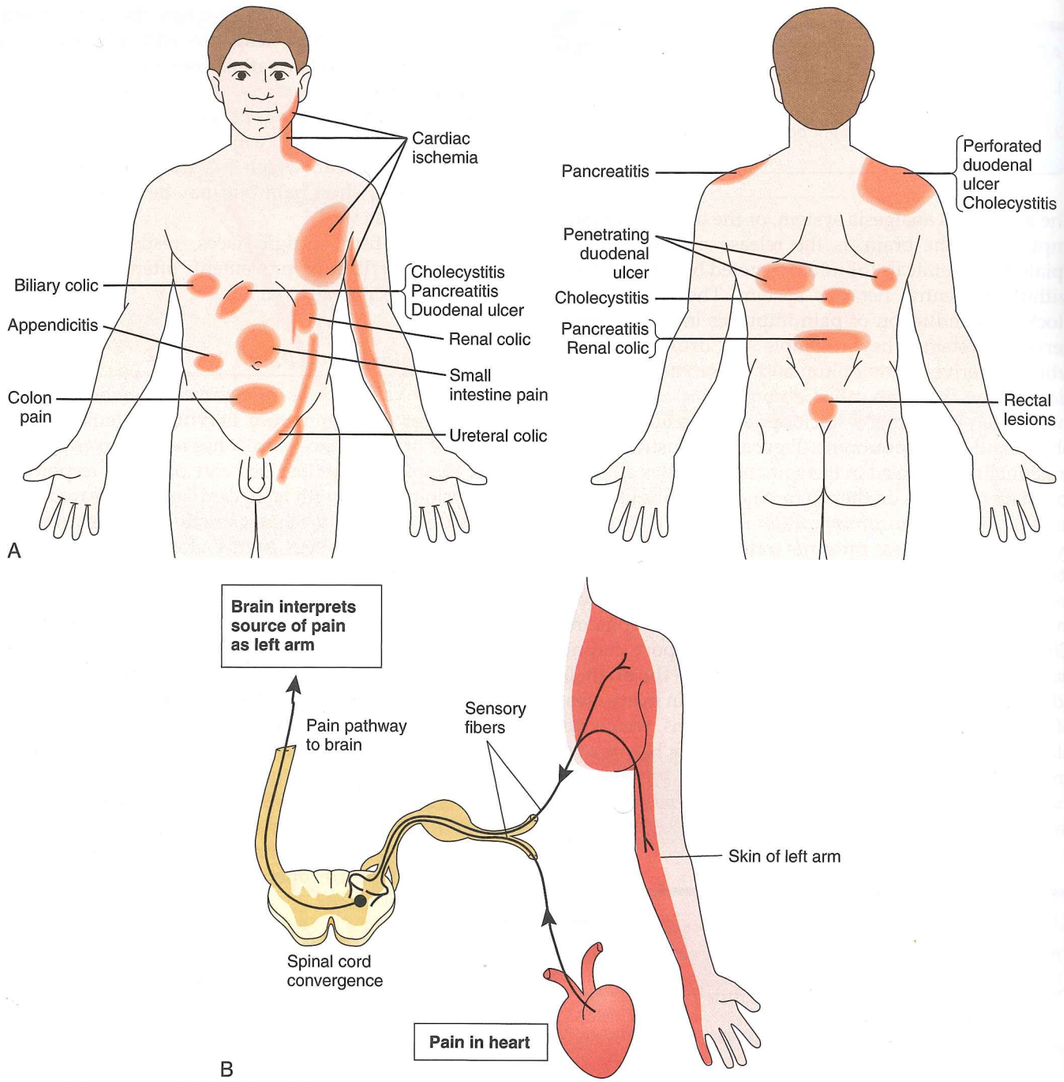

FIGURE 4-3 **A**, Locations of referred pain. **B**, Proposed mechanism for referred pain. *(**A**, From Copstead-Kirkorn LC:* Pathophysiology, *ed 4, St. Louis, 2009, Mosby.)*

spinal cord make it difficult for the brain to discern the actual origin of the pain.

Phantom Pain

Pain or another sensation such as itching or tingling occurs in some individuals, usually adults, after an amputation. Pain is perceived by the person as occurring in the lost limb and usually does not respond to usual pain therapies. The pain may resolve within weeks to months. Although the phenomenon is not fully understood, it appears that the brain "understands" the limb is still present when processing incoming stimuli. Research suggests that a history of prolonged or severe chronic pain before surgery increases the probability of phantom pain developing.

Pain Perception and Response

Pain tolerance is the degree of pain, either its intensity or its duration, which is endured before an individual takes some action. Tolerance may be increased by endorphin release or reduced by other factors such as fatigue or stress. Tolerance does not necessarily depend on the severity of the pain. Rather, it varies among people and different situations.

Pain perception and response are subjective and depend on the conditioning of the individual. Factors such as age, culture, family traditions, and prior experience with pain shape one's perception and response to pain. For example, in certain groups it is customary to approach pain with stoic acceptance, whereas in other groups the proper response would include loud crying and wailing. Prior unpleasant experiences and anticipatory fear or anxiety can lower pain tolerance, magnifying the extent of the pain and the victim's response.

An individual's temperament and personality can influence his or her response to pain, and the circumstances existing at the time of the incident may affect perception of it. Anxiety, fear, and stress can increase the severity of pain because in these circumstances the central nervous system is at a higher level of awareness. Fatigue, hunger, and the presence of other pathologies or problems may magnify a person's response. Likewise, the specific cause of the pain and its implications with respect to body image, family relationships, or employment responsibilities might alter the person's perception of pain and his or her response to it.

THINK ABOUT 4-4

a. From your own experience, describe a sharp pain, an aching pain, and a cramping pain.
b. List factors that often make pain seem more severe.
c. Differentiate pain threshold from pain tolerance.

Basic Classifications of Pain

Acute Pain

- Acute pain is usually sudden and severe, but short term.
- It indicates tissue damage and decreases once the cause has been treated.
- It may be localized or generalized.
- Acute pain usually initiates a physiologic stress response with increased blood pressure and heart rate; cool, pale, moist skin; increased respiratory rate; and increased skeletal muscle tension (see Chapter 26).
- Vomiting may occur.
- In addition, there may be a strong emotional response, as indicated by facial or verbal expression and a high anxiety level.

Chronic Pain

Long-term pain leads to different and often negative effects such as loss of employment or interference with personal relationships.

- Chronic pain is usually more difficult to treat effectively than acute pain, and the prognosis may be less certain.
- Chronic pain is often perceived by the patient as being more generalized, and it is difficult to discern an exact location.
- Because a specific cause may be less apparent to the person experiencing the pain, the pain is more difficult to deal with and can be quite debilitating.
- It is impossible to sustain a stress response over a long period of time, and the individual with chronic pain frequently is fatigued, irritable, and depressed.
- Sleep disturbances are common, and appetite may be affected, leading to weight gain or loss.
- Constant pain frequently affects daily activities and may become a primary focus in the life of the individual, thus complicating any measures to affect pain control by medication or other methods. Effective support from the health care team and a caring approach that does not minimize the person's pain may significantly reduce the client's focus on controlling pain.
- Periods of acute pain may accompany exacerbations of chronic disease, making it more difficult for the patient to participate effectively in a pain management program.
- Long-term pain usually reduces tolerance to any additional injury or illness.
- Table 4-1 provides a brief comparison of acute and chronic pain.

THINK ABOUT 4-5

Compare the characteristics of acute and chronic pain.

Headache

Headache is a very common type of pain. There are many categories of headache associated with different causes, and some have specific locations and characteristics.

1. Headaches associated with congested sinuses, nasal congestion, and eyestrain are located in the eye and forehead areas. Sinus headaches can be quite severe. These headaches are usually steady and relieved when the cause is removed.
2. Headaches associated with muscle spasm and tension result from emotional stress and cause the neck muscles to contract to a greater degree, pulling on the scalp. Sometimes when people work for long periods of time in one position, contraction and spasm of the

TABLE 4-1 General Comparison of Acute and Chronic Pain

Acute Pain	Chronic Pain
Type	
A warning: fast, localized	Slow, diffuse, prolonged
Stimuli	
Injury: mechanical, thermal	Existing, chemical
Pathway	
Fast A-delta myelinated fibers	Slow unmyelinated C fibers
Neospinothalamic tract	Paleospinothalamic tract
Response	
Sudden, short-term	Long-term, disabling
Stress response; increased pulse and blood pressure: cool, moist skin; nausea/vomiting	Fatigue, depression, irritability
Emotion	
Anxiety	Loss of hope, depression, anger
Treatment	
If cause is identified, treatment is effective	Difficult to treat effectively

neck muscles also result, causing a dull, constant ache usually in the occipital area. Tension headaches tend to persist for days or weeks.

3. Headache in the temporal area is often associated with temporomandibular joint (TMJ) syndrome, in which the underlying cause is a malocclusion involving the jaw or inflammation of the joint due to arthritis or poor body alignment which causes muscle tension in the neck that is transferred to the jaw.
4. *Migraine* headaches are related to abnormal changes in blood flow and metabolism in the brain, but the exact mechanism is not yet fully understood. Research has suggested that migraines may be caused by the following reactions:
   a. Increased neural activity spreads over areas of the brain initiating pain stimuli in the trigeminal system, which are then conducted to the thalamus and pain centers in the sensory cortex.
   b. An accompanying reduction in serotonin is observed during migraine headaches and may cause the release of *neuropeptides*, which travel to the meninges covering the brain.
   c. These neuropeptides act on the smooth muscle of the blood vessels in the meninges, causing stretching and inflammation. The result is severe vascular pain.

   There are many precipitating factors, including atmospheric changes, stress, menstruation, dietary choices, and hunger.

The pain associated with a migraine is usually throbbing and severe and is often incapacitating. Characteristically, migraine headaches begin unilaterally in the temple area but often spread to involve the entire head. The pain is often accompanied or preceded by visual disturbances and dizziness, nausea and abdominal discomfort, and fatigue. These headaches may last up to 24 hours, and there is often a prolonged recovery period. Mild migraine may be treated with nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen (Advil, Motrin, and others) and acetaminophen (Tylenol and others). Moderate migraine pain often responds to a combination of acetaminophen, codeine, and caffeine, or acetaminophen, aspirin, and caffeine (Excedrin migraine).

Treatment of severe migraine pain is difficult, although ergotamine can be effective if it is administered *immediately* after the onset of the headache. Newer forms of ergotamine are available in a soluble tablet to be placed under the tongue, thus providing a more readily available and rapid-acting form of the drug and a combination of ergotamine and caffeine can also be used. The drugs of choice for severe migraine are the triptans that act on some 5-HT (5-hydroxytriptamine) receptors to block the vasodilation and release of vasoactive peptides in the brain. These drugs relieve the nausea and light sensitivity as well as pain and nausea. Commercial examples of this family of drugs are almotriptan (Axert), rizatriptan (Maxalt), sumatriptan (Imitrex), naratriptan (Amerge), zolmitriptan (Zomig), frovatriptan (Frova), and eletriptan (Relpax). In severe cases, opiates such as codeine may be used but due to the habit-forming nature of these narcotics, they are considered a last resort measure.

Preventive medication may be used by some patients on a daily basis or just before a known migraine trigger. These drugs include several cardiovascular drug groups usually used for hypertension, the beta-blockers and calcium channel blockers (see Chapter 12). The older tricyclic antidepressants such as amitriptyline (Elavil) may be helpful because they raise serotonin and norepinephrine levels. Migraine clinics are researching the hereditary factors as well as individual exacerbating factors.

5. *Intracranial* headaches result from increased pressure inside the skull. Any space-occupying mass stretches the cerebral vascular walls or the meninges covering the brain. Causes of increased pressure include trauma with edema or hemorrhage, tumors, infections such as meningitis, or inflammation resulting from toxins such as alcohol. Headaches may be occipital or frontal in location depending on the site of the problem. Usually other indicators of increased intracranial pressure accompany the headache (see Chapter 14).

THINK ABOUT 4-6

Compare the signs of a migraine headache with those of a tension headache.

Central Pain

Central pain is pain that is caused by dysfunction or damage to the brain or spinal cord. A lesion such as abscess, infarction, hemorrhage, tumor, or damage resulting from direct injury may cause central pain. This type of pain can be very localized or can involve a large area of the body. It is persistent, irritating, and can cause considerable suffered over an extended period of time.

Neuropathic Pain

Neuropathic pain is caused by trauma or disease involving the peripheral nerves. This type of pain can vary from a tingling to a burning or severe shooting pain. Movement can stimulate this pain as well as injured nerves that can become hyperexcitable and some neurons with low thresholds for thermal, mechanical or chemical stimuli may spontaneously fire. Neuralgias are examples of extremely painful conditions that are a result of damage to peripheral nerves caused by infection or disease. Causalgia is a type of neuralgia that involves severe burning pain that can be triggered by normally "nontraumatic" stimuli such as a light touch, sound or cold.

Ischemic Pain

Ischemic pain results from a profound, sudden loss of blood flow to an organ or tissues in a specific area of the body. The decreased blood supply results in hypoxia, which leads to tissue damage and the release of inflammatory and pain-producing substances. The description of the pain may vary from aching, burning, or prickling to a strong shooting pain (particularly in an extremity). The exact symptoms depend on the location of the hypoxic tissue and can be characterized as either acute or chronic pain. Atherosclerotic disorders that cause blocking of arterial flow can cause ischemic pain, particularly in the lower extremities. Improving blood flow and preventing/reducing tissue hypoxia can do much to manage ischemic pain.

Cancer-Related Pain

Cancer is very often associated with pain, usually chronic pain. This pain has been broken down into several categories: pain caused by the advance of the disease and resultant damage to the body, pain associated with the treatment of the disease, and pain that is the result of a coexisting disease unrelated to the cancer. The most common category encountered in cancer-related pain is that which is caused by the advance of the disease. As the tumors grow, they can cause infections and inflammation, which in turn cause increased pressure on nerve endings, stretching of tissues, or obstruction of vessels, ducts, or the intestines. This type of pain may be characterized as acute with sudden onset, intermittent, or chronic persisting over a long period of time.

Pain Control

Methods of Managing Pain

Pain can be managed in a number of ways in addition to removing the cause as soon as possible. The most common method is the use of analgesic medications to relieve pain. These drugs may be administered in a variety of ways, including orally or **parenterally** (by injection) or transdermal patch. New drugs are constantly being developed to improve the efficacy of treatment and reduce side effects. Analgesics are frequently classified by their ability to relieve mild, moderate, or severe pain (Table 4-2).

Mild pain is usually managed with acetaminophen (Tylenol) or acetylsalicylic acid (ASA, aspirin), which act primarily at the peripheral site. The latter is particularly useful when inflammation is present, whereas the former is popular because it has fewer side effects. Acetylsalicylic acid also acts as a platelet inhibitor, reducing blood clotting. NSAIDs, such as naproxen and ibuprofen, are widely used to treat both acute and chronic pain, particularly when inflammation is present (see Chapter 5 for more information on inflammation and drugs). In addition, these drugs possess antipyretic action, lowering body temperature in case of fever. Even in high doses, this group of drugs is not effective for severe pain.

For *moderate* pain, codeine is commonly used, either alone, or more frequently, in combination with acetaminophen or aspirin. Codeine is a narcotic, a morphine derivative, acting at the opiate receptors in the central nervous system. Codeine exhibits some adverse effects, causing nausea, constipation, and in high doses, respiratory depression. Taking the drug with food or milk reduces gastric irritation. Another choice is oxycodone, a synthetic narcotic combined with acetaminophen or aspirin (Percocet or Percodan). This drug affects the perception of pain and emotional response, promoting relaxation and a sense of well-being, predisposing to dependency. Oxycodone abuse has become a significant problem (see Chapter 27).

For *severe* pain, morphine, hydromorphone, or other narcotics are favored. These drugs block the pain pathways in the spinal cord and brain and also alter the perception of pain in a positive manner. In long-term use, tolerance often develops, requiring a higher dose to

TABLE 4-2 Analgesic Drugs

Use	Name	Action	Adverse Effects
For Mild Pain			
	ASA* Acetaminophen NSAIDs*	Decreases pain at peripheral site All are antipyretic ASA and NSAIDs are anti-inflammatory	ASA and NSAIDs have many adverse effects (nausea, gastric ulcers, bleeding, allergies)
For Moderate Pain			
	Codeine Oxycodone Percocet Vicodin	Acts on central nervous system and affects perception	Narcotic (opium)—often combined with ASA/acetaminophen High dose may depress respiration
For Severe Pain			
	Morphine Demerol Methadone Meperidine Oxycodone	Acts on central nervous system; euphoria and sedation	Narcotic—Tolerance and addiction High dose depresses respiration; nausea, constipation common.

*ASA, acetylsalicylic acid (aspirin); NSAIDs, nonsteroidal anti-inflammatory drugs.

be effective or an alternative drug. Narcotics have a number of adverse effects, and concern is often expressed about addiction with long-term use. However, addiction does not always develop, and in most cases it is more important to ensure that pain is managed effectively. Meperidine is helpful for short-term pain, but its brief duration of action as well as continuous usage, which results in a buildup of a toxic metabolite, prevents its use for severe chronic pain.

Sedatives and antianxiety drugs (minor tranquilizers such as lorazepam) are popular adjuncts to analgesic therapy because they promote rest and relaxation and reduce the dosage requirement for the analgesic. The muscle relaxation that is a side effect of the medication is also helpful in relieving or preventing muscle spasm associated with pain.

In patients with chronic and increasing pain, such as occurs in some cases of cancer, pain management requires a judicious choice of drugs used in a stepwise fashion to maximize the reduction of pain. Usually tolerance to narcotic drugs develops in time, requiring an increase in dosage to be effective. Eventually a new drug may be required.

Many patients with severe pain administer their own medications as needed, using *patient-controlled analgesia (PCA)*. Small pumps are attached to vascular access sites, and the patient either receives a dose of analgesic such as morphine when needed or maintains a continuous infusion. This has been a highly successful approach and has been found to lessen the overall consumption of narcotics.

Other pain control methods may accompany the use of medications. Pain management clinics offer a variety of therapeutic modalities for the individual. Such measures include stress reduction and relaxation therapy, distraction, applications of heat and cold, massage, physiotherapy modalities, exercise, therapeutic touch, hypnosis imaging, and acupuncture (see Chapter 3). These measures may act in the spinal cord at the "gate" or may modify pain perception and response in the brain. Many of these strategies are believed to increase the levels of circulating endorphins that elevate the pain tolerance. Also, maintenance of basic nutrition and activity levels as well as adequate rest assist people in coping with pain. Specialized clinics deal with certain types of pain such as chronic back pain or temporal mandibular joint pain.

For **intractable** pain that cannot be controlled with medications, surgical intervention is a choice. Procedures such as **rhizotomy** or **cordotomy** to sever the sensory nerve pathway in the spinal nerve or cord may be done. Injections can be given with similar effects. These procedures carry a risk of interference with other nerve fibers and functions, particularly when the spinal cord is involved.

Anesthesia

Local anesthesia may be injected or applied topically to the skin or mucous membranes (Table 4-3). Local anesthetics may be used to block transmission of pain stimuli from a specific small area. For example, an injection of lidocaine may be given before performing a tooth extraction, removal of a skin lesion, or a diagnostic procedure that is likely to be painful. A long-acting, localized block may be used to reduce pain after some surgeries.

Spinal or *regional anesthesia* may be administered to block pain impulses from the legs or abdomen. Spinal anesthesia involves administering a local anesthetic into the epidural space or the cerebrospinal fluid in the subarachnoid space at an appropriate level, blocking all nerve conduction at and below that level.

TABLE 4-3 Anesthetics

Type	Example	Effects	Purpose
1. Local anesthetic	Lidocaine; injected or topical; may add epinephrine	Blocks nerve conduction (sensory) in a peripheral nerve	Removal of a skin lesion; tooth extraction
2. General anesthetic	Intravenous—thiopental sodium Inhalation (gas)—nitrous oxide	Affects brain—partial or total loss of consciousness	General surgery, no pain/awareness when combined with analgesic
Relative or neuroleptanesthesia	Diazepam or droperidol	Can respond	
3. Spinal anesthesia	Local anesthetic injected into subarachnoid or epidural space around lower spinal cord	Blocks nerve conduction (sensation) at and below level of injection	Surgery on lower part of body: labor and delivery

General anesthesia involves administering a gas to be inhaled such as nitrous oxide or injecting a barbiturate such as sodium pentothal intravenously. Loss of consciousness accompanies general anesthesia. Analgesics are required with these drugs. *Neuroleptanesthesia* is a type of general anesthesia in which the patient can respond to commands but is relatively unaware of the procedure or of any discomfort. For example, diazepam can be administered intravenously in combination with a narcotic analgesic such as meperidine or morphine. Droperidol (a neuroleptic) and fentanyl (a narcotic analgesic) are a popular combination (e.g., Innovar) that is administered by intravenous or intramuscular injection.

CASE STUDY A

Acute Pain

L.Y. is a healthy 13-year-old who had all her wisdom teeth removed 6 hours ago and is experiencing significant pain. She has been prescribed acetaminophen and codeine for pain relief and is at home recovering. Her mother wants her to rest and stop text messaging her friends about her dental surgery.

1. How do acetaminophen and codeine act to reduce pain? What is a side effect of high levels of each drug? Why has the dentist prescribed only a limited supply of the medication?
2. How does L.Y.'s text messaging behavior affect her perception of pain?
3. Does L.Y. need to rest in bed quietly to reduce pain?
4. L.Y. becomes increasingly irritated with her mother and tells her to "get off my case." How does L.Y.'s stress affect pain perception?

CASE STUDY B

Chronic Pain

Ms. J. is a 30-year-old healthy single mother with two children. She has worked as a paramedic in her community for 6 years. She and her partner responded to a call involving a man who had been drinking heavily at a family party and who was partially conscious. When she and her partner attempted to transfer the 100-kg man to a stretcher, the man grabbed her neck, causing her severe pain. Ms. J.'s doctor diagnosed a spinal injury and completed papers for Ms. J. to be absent from work. He recommended rest and application of heat and cold to the neck. One week later, Ms. J. saw him again, reporting continuing pain. She was referred to a specialist who told her she had a herniated disk in the cervical area of her neck and would require ongoing care and rehabilitation. Ms. J. has been on disability leave for 6 months, during which she has continued to have severe neck, jaw, and back pain. She takes acetaminophen with codeine as required, and sees a physiotherapist and a registered massage therapist routinely in an attempt to control chronic pain. She is worried that her disability benefits will cease before she can return to work and has incurred debts during her leave. She also finds it difficult to care for her two children and keep the house clean.

1. What factors are significant in Ms. J.'s perception of pain? How might each be reduced?
2. Why has Ms. J.'s doctor not prescribed stronger narcotic medication?
3. Why does Ms. J. experience pain in her jaw and lower back when the injury was to her neck?
4. Where in the pain pathway do massage therapy and physiotherapy act to alleviate pain?
5. Ms. J. is concerned about maintaining her physical fitness and decides to attend exercise classes in her community pool. She finds this gives her more energy and reduces her pain. How does appropriate exercise affect pain perception? What precautions does Ms. J. need to observe when exercising?
6. Ms. J. hears about acupuncture as a help for back pain and does some research on the Internet before making an appointment for treatment. How could acupuncture act to block impulses for pain?
7. After 8 months, Ms. J. is cleared to return to work on a part-time basis, which she manages well. Why does she not return to full-time work immediately?
8. What can Ms. J. expect in the future as a result of this injury?

CHAPTER SUMMARY

Pain serves as one of the body's defense mechanisms, resulting from stimulation of nociceptors by ischemia, chemical mediators, or distention of tissue.

- The pain pathway may be interrupted at many points, including the receptor site, a peripheral nerve, the spinal cord, or the brain.
- The gate control theory recognizes the role of synapses serving as open or closed gates at points in the pain pathway in the central nervous system. These gates may close under the influence of natural endorphins or other stimuli, thus inhibiting the passage of pain impulses to the brain.
- Descriptions of pain are subjective evaluations by an individual.
- Referred pain occurs when an individual locates the pain at a site other than the actual origin.
- An individual's perception of and response to pain depend on prior conditioning and experiences.
- Acute pain is usually sudden and severe but short term. Chronic pain is milder but long lasting. The person with chronic pain is often fatigued and depressed.
- There are many types of headaches, among them tension, sinus, and migraine, each with different characteristics.
- Analgesics are rated for the severity of pain controlled by the drug; for example, aspirin for mild pain and morphine for severe pain.
- Anesthesia may be classified as local, spinal or regional, or general.

STUDY QUESTIONS

1. Describe the characteristics and role of each of the following in the pain pathway:
   a. nociceptor
   b. C fibers
   c. spinothalamic tract
   d. parietal lobe
   e. reticular formation
   f. endorphins and enkephalins
2. Define and give an example of referred pain.
3. Differentiate the characteristics of acute and intractable pain.
4. List several factors that can alter the perception of pain and the response to pain.
5. Briefly describe six possible methods of pain control.

ADDITIONAL RESOURCES

Mosby's Drug Consult 2006, St. Louis, 2006, Mosby.

Web Sites

http://www.ampainsoc.org *American Pain Society*
http://www.mayoclinic.com *Mayo Clinic*
http://www.webmd.com/pain-management/default.htm
http://www.webmd.com/pain-management/guide/11-tips-for-living-with-chronic-pain
http://www.cancer.org/ssLINK/pain-control-toc

SECTION II

Defense/Protective Mechanisms

CHAPTER 5

Inflammation and Healing

CHAPTER OUTLINE

LEARNING OBJECTIVES

After studying this chapter, the student is expected to:

1. Explain the role of normal defenses in preventing disease.
2. Describe how changes in capillary exchange affect the tissues and the blood components.
3. Compare normal capillary exchange with exchange during the inflammatory response.
4. Describe the local and systemic effects of inflammation.
5. Explain the effects of chronic inflammation.
6. Discuss the modes of treatment of inflammation.
7. Describe the types of healing and the disadvantages of each.
8. List the factors, including a specific example for each, that hasten healing.
9. Identify the classifications of burns and describe the effects of burns.
10. Describe the possible complications occurring in the first few days after a burn.
11. Explain three reasons why the healing of a burn may be difficult.