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Essentials of Pain Management

Springer

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To my parents; my husband, Thangamuthu Kodumudi; my sons, Gopal and Vijay; and all my wonderful colleagues.

- N.V.

I would like to thank my parents, my wife Zina Matlyuk-Urman, MD for their love and encouragement, and all my colleagues and mentors for their inspiration.

- R.D.U.

I would like to dedicate this book to all my teachers and students who have been so instrumental in my career.

- R.L.H.

Preface to the Case Scenarios

When presented with pain, we, as healthcare professionals, are asked to find appropriate solutions. The clinical presentation may be acute or chronic, and successful management involves an accurate diagnosis and implementation of a suitable therapy or therapies. For a beginner in pain management, this can pose a significant challenge. We have placed a clinical scenario at the end of nearly all of the chapters, for a total of 33 cases, in an attempt to present a collection of common pain-related clinical problems and possible ways to manage them effectively.

Treatment of pain begins with a detailed history taking, a thorough clinical examination, specific investigations, and the right intervention. The importance of history and clinical examination in pain management cannot be overstressed. The knowledge, attitude, and skills needed in managing pain are acquired over time, and the management involves multidisciplinary teams and multimodal approaches. This is exemplified in the clinical scenarios. It is also important to re-explore and re-assess when there is a change in the clinical picture.

The clinical scenarios are presented in a question-and-answer format. The reader is encouraged to go through the questions first and to come up with a solution before reading the given answer. There is always a potential for a different approach to the given clinical problem.

Many of these scenarios were taken from our day-to-day practice of pain medicine. While we have presented the scenarios in a positive note with regard to the effectiveness of pain management strategies, we have the humility to admit that we may sometimes be too optimistic in our outlook.

Dr. Sreekumar Kunnumpurath,
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Preface

Essentials of Pain Management is a concise yet comprehensive evidence-based guide to what is now recognized as the "fifth vital sign." We wrote it to provide an in-depth review of clinical principles and procedures that stresses the multidisciplinary, practical approach to pain management. With contributions from a cross section of pain experts, the book is designed to help the pain management professional in any specialty and at any stage of training to provide the most up-do-date, evidence-based care.

We cover a wide variety of topics including pharmacology, palliative medicine, physical therapy, acupuncture, behavioral and interventional therapy, and pain management in pediatric and elderly populations. We also cover topics of importance to nurses and dentists. In addition, the book also contains the most up-do-date pain drug formulary for easy reference.

Another unique feature is a collection of multiple choice questions with detailed explanations, useful for chapter review and exam preparation. We also included practical case vignettes to follow each chapter. These vignettes illustrate specific pain management challenges and provide detailed sample solutions. The vignettes are a useful way to apply the knowledge obtained from reading the chapter to a real patient situation.

We would like the thank all of our contributors for their expertise, our colleagues and trainees for their inspiration, and our families for their patience and moral support. Whether you are a student or a practicing healthcare professional, we hope that you will find *Essentials of Pain Management* an indispensable guide to pain management.

Nalini Vadivelu, MD
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Foreword

"Just the facts, ma'am." Those who remember the early days of television recall this often used line by Sgt. Joe Friday in the long running series, *Dragnet*. Fast-forward 50 years and facts are as accessible as the swiftness of one's "thumb typing abilities." However, another time-honored adage, "caveat emptor" ("let the buyer beware") reminds us that fast facts obtained between cases or patient visits from Internet search sites can both produce a morass of too many "hits" and run the risk of obtaining misinformation from an unreliable source.

While the world continues to transition from libraries with stacks of periodicals to virtual libraries, the contemporary professional will still benefit from a handy, concise, and authoritative compendium of essential information written by expert faculty who have thoroughly researched and distilled the topics to their key points of information.

Drs. Vadivelu, Urman, and Hines have provided the interested practitioner with an informative and diverse text on practice topics pertinent to the multidisciplinary specialty of pain medicine. This book should especially appeal to health-related professions, trainees, and faculty as well as pain fellows and practicing physicians who need a source with a high probability of quickly providing the needed information. A novel feature included in the book assists the reader's understanding of the material within a clinical context by providing short case scenarios.

Essentials of Pain Management is logically divided into nine parts of pertinent pain topics and even includes a section on "Non-pharmacologic Management of Pain." The appendix contains multiple choice questions that will assist students and residents in preparing for examinations.

The editors should be congratulated for assembling an enthusiastic group of pain specialist authors to produce this handy reference manual useful to providers at all levels of the analgesic care continuum. In my program, every resident carries a smart phone, but it is more common for me to see them reading a text for their didactic instruction.

Buffalo, NY — Mark J. Lema, MD, PhD

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Section I

Introduction

Chapter 1

Introduction to Pain Management, Historical Perspectives, and Careers in Pain Management

Erica Bial, MS, MD and Doris K. Cope, MD

Introduction: The Need for Historical Perspective on Pain

The importance of recognizing, assessing, understanding, and treating pain is central to the role of any caregiver. When a patient presents to the physician, he rarely comes labeled with a given diagnosis; rather, he more often has a chief "complaint" that he suffers in some manner. To the patient, the symptom, not the pathology or disease, is the affliction. As such, it is imperative that we respect and understand that pain and suffering are the often primary reasons that patients seek medical care for.

The necessary nature of pain treatment has long been categorized among other basic human rights, and in 1999 the Joint Commission on Accreditation of Healthcare Organizations formalized pain standards to ensure to all patients their right to appropriate assessment and management of their pain, describing pain as the "fifth vital sign (Lanser 2001)." Intrinsic to our capacity to treat pain is possession of perspective of the many cultural beliefs, philosophical ideologies, and scientific discoveries that have influenced and evolved into the modern Western conceptualization of pain.

Why would we stress the importance of the *history* of pain medicine? History helps us understand our own place in the universe as healers. We need to appreciate our past in order to gain a sense of connectivity and perspective that is inherent in establishing our identity as a professional. Hundreds of years hence, our theoretical constructs and clinical practices may be considered quaint and outmoded, but the essence of professionalism and the critical, scientific study of medicine will remain unchanged through the ages. Like the times before us, our current era is an exciting one for the study and treatment of pain. With rapidly evolving capacity to elucidate ever more microscopic scientific detail of the anatomy and physiology of pain, developing technologies yield a vast scientific understanding and lexicon of pain. As developments in laboratory and clinical science continue to increase our capacity to further reduce pain to its biological components, simultaneously we must possess the knowledge and vocabulary to discuss pain with our patients in this time of great renewed public interest in many of the "old" medical arts. With a majority of our patients now choosing to partake of complementary and alternative medicine approaches (Barnes 2002), there is a renewed and growing public interest in a more holistic medical model which requires us to recognize that

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"everything old is new again." Likewise, having an intercultural and historical appreciation and perspective on pain is an asset to any clinician.

Defining "pain" in a succinct manner is a great challenge. What is pain? It has been described as an emotional state, a physical experience, a spiritual sacrament, and a complex set of interconnected subcellular signals. This chapter will discuss this plurality of concepts. From the mind–body dilemma, through the larger context of how our intellectual constructs shape our understanding, we will consider some of the historical and evolving treatment approaches of this complex phenomenon we call pain. The chapter will close with a discussion of how the medical subspecialty of pain management is evolving within the broader context of medical specialization and thoughts for future development (Benedelow and Williams 1995).

Evolving Concepts of Pain

Over time and across cultures, the understanding and expression of pain reflects the contemporary spirit of the age. Universally, the human experience begins through the painful process of birth, and throughout our lifetimes, the experience of pains-physical, emotional, and spiritual-persists as a part of this common experience. The experience of suffering remains universal. However, the expression and meaning of pain have changed over recorded history with changing world views. There has been great debate and discussion as to the origin and nature of pain. It has been viewed as an imbalance of vital forces, a punishment or pathway to spiritual reward, an emotional or behavioral experience, and, relatively recently, as a biological phenomenon.

Among the earliest recorded systems of pain management, dating back over 4,000 years, is Chinese acupuncture. In this medical system, pain is felt to represent an imbalance between *yin* and *yang*, the two vital opposing attributes of life force, or *qi*. Later, the ancient Egyptians considered the experience of pain to be a god or disincarnate spirit afflicting the heart, which was conceptualized as the center of emotion. Aristotle and later Galen both described pain as an emotional experience or "a passion of the soul (Birk 2006)."

In different places and in different points over time, both Eastern and Western medical traditions have included a concept of imbalance as an important etiology of painful symptoms. Unsurprisingly, these ideas emerged alongside the thinking of agrarian societies, integrating the knowledge and experience emerging during that age. During the Han dynasty, approximately 2nd century BCE, the *Huang Di Nei Jing* described the body as a microcosmic representation of the forces of the universe and defined the physician's role as assisting in maintaining the harmonious balance of those forces, both internally as well as in relation to the larger external environment. As such, the concept of *Five Elements* evolved. External bodily invasions (by wind, heat, dampness, dryness, and cold), as well as internal susceptibility (to anger, excitement, worry, sadness, and fear), could affect the balance of energy and humors related to a traditional understanding of the functions of the internal organs. Descriptors from nature (wood, fire, earth, metal, and water) are still used today to codify these traits, symptoms, and imbalances, as summarized in Table 1.1 (Helms 1998).

Somewhat similarly, in the Western world, dating from antiquity and persisting until the 19th century, was the theory of the *Importance of the Four Humors*. This theory was first espoused by Greek philosophers in approximately 400 BC and later applied to medicine by Hippocrates, who described the humors as related to one of the four constitutions, each of which was also correlated with the changing seasons and representative natural elements, as

Table 1.1 Overview of the traditional Chinese *Five Elements*.

Element	Organ systems	Emotions	Taste	Basic function
Fire	Heart, small intestine	Excitement, joy	Bitter/roasted	Generation of warmth, energy, Circulation of blood, promotion of activity
Earth	Stomach, spleen	Sympathy, worry	Sweet	Digestion, metabolism, utilization of nutrients to build body
Metal	Lungs, colon	Grief, sadness	Pungent	Processing waste, protecting body from infection, regulating vital energy
Water	Kidneys, bladder	Fear, fatigue	Salty	Balance of water and minerals, storing and generating basic life force, strength and body integrity
Wood	Liver, gallbladder	Anger, irritability, emotional volatility	Sour	Builds and stores blood, regulates smooth flow of *qi*

Adapted from Rey (1955).

Table 1.2 Overview of the *Four Humors*.

Humor	Black bile	Blood	Phlegm	Yellow bile
Element	Earth	Air	Water	Fire
Constitution	Dry, cold	Hot, wet	Cold, wet	Hot, dry
Season	Autumn	Spring	Winter	Summer

Adapted from Rey (1955).

summarized in Table 1.2. Seasonal changes could evoke particular imbalances of the humors, yielding certain disorders. For example, headache was attributed to excessive cold humors thought to result in a mucus discharge requiring application of "hot effusions" to the head. Interestingly, a similar process of excess "liver fire" was one explanation of headache in the traditional system of Chinese medicine. Consistent with both ideologies was the custom of treating pain by applying "opposites," such as hot applications to the head to counterbalance and evacuate "cold" humors of headaches (King 1988) in the *Four Humors* system, while the imbalance of excess liver fire could be "dispersed" through needles inserted along the liver meridian and then cooled with alcohol. Used in both Eastern and Western tradition was the technique called *cupping*. Warm suction cups were applied to the skin that on cooling resulted in raised reddened welts thought to "draw out" any unbalanced humors (Rey 1955) or unblock stagnant *qi*. The practice of cupping continues today in traditional Chinese medicine, and the sight of healing cupping welts has been widely photographed on the backs of Hollywood's elite.

Another example of pain viewed as representative of energy imbalances in the body came as *vitalism*. Vitalism theory asserted that every part of a living thing was endowed with "sensibility" and the vital animating force of a living organism was capable of being either stimulated or consumed. In this model of disease, pain was necessary to produce a "crisis" in order to rid the patient of the original pain by stimulating his waning energy (Rey 1955). The work of German physician Franz Anton Mesmer, which developed into the well-known practice of mesmerism, was based on this belief. In 1766, he published his doctoral dissertation

entitled "On the Influence of the Planets on the Human Body," wherein he described animal magnetism as a force to cure many ills (Académie nationale de médecine 1833). He used iron magnets to treat various diseases, making a spectacle of amplifying magnetic fields with room-sized Leyden jars, imbuing his actions with mystical rites by wearing colored robes in dimly lit ritualistic séances with soft music playing from a glass harmonium. Mesmerism was so well regarded that it represented an early rival to ether anesthesia as a way to relieve pain during surgical procedures (Zimmermann 2005). During his day, Robert Liston reportedly exclaimed after the successful administration of ether anesthesia, "This Yankee Dodge beats mesmerism hollow (Squire 1888)."

Religious explanations of pain have also been prevalent in various times and cultures. Pain has been explained as a possession of the body by an angry deity in many cultures. Much like the earlier Egyptians, coincident with the spread of Christianity during the Middle Ages in Europe, pain was explained in a spiritual, religious context. While little is known of if or how pain was actually treated during this period, the images of a suffering Christ, martyred saints, and the concept of physical pain in purgatory originated around the 12th century (Rey 1955, Bonica 1953). One clear example of pain as ennobling was St. Ignatius Loyola's habit of wearing ropes and chains cutting into the skin and encouraging other humiliations of the flesh to enhance his spiritual development (Birk 2006). The persistence of this practice in the current era was explored in the widely popular 2003 novel *The DaVinci Code* (Brown 2003).

Pain has also been viewed as an emotional or behavioral phenomenon. Beginning in the 17th century and persisting through the turn of the 19th century, huge numbers of female invalids filled convalescent homes, spas, and sanitariums, bearing the diagnosis of "hysteria." In 1681, Thomas Sydenham wrote, "Of all chronic diseases hysteria–unless I err–is the commonest (Epistolary Dissertation 1681)." The cardinal symptom of this outbreak was unexplained pain. The mysterious syndrome of hysteria afflicted only middle and upper class females and commonly was treated by social isolation, bed confinement, and a total prohibition on any form of intellectual activity, even the women's work of sewing or reading (Gilman 1935). However, as social and educational opportunities for women improved, this disorder almost totally disappeared—resolving hundreds of years of suffering on the order of magnitude of the eradication of influenza or yellow fever. Clearly, there are multitudes of modern day examples of painful disorders that can be linked to social and behavioral etiologies. A most prevalent example in the 21st century is fibromyalgia. While it is a commonly diagnosed disorder in Western countries, interestingly enough, it is either underreported or not significantly present in Asian and Third World populations. Additionally, this disorder is characterized by widespread, not-otherwise-explained pain, has a dramatic predilection for women, and a high degree of concomitance with depression and sleep disorders—not at all unlike the hysteria of eons past.

Further discussion of the mind–body pain connection would be incomplete without mention of the landmark development of Freudian theory in understanding the subconscious influences on pain perception and behavior. The link between the unconscious mind and physical sensation in hysterical conversion disorders was posited as an explanation for psychogenic pain and continues to be influential today. This conceptual paradigm was expanded in the 1970s by the psychiatrist George L. Engel, who demonstrated the link between chronic pain and psychiatric illness (Engel 1958). Depression, stress, and personality, in addition to physiological mechanisms, have proved to be critical grounds for investigation and therapy. In the 1980s, the cognitive behavioral school of pain therapy, which is widely employed today,

expanded the role of the mind–body connection in pain medicine, emphasizing the development of coping mechanisms to deal with chronic pain. Cognitive behavioral therapy, with particular attention paid to coping mechanisms and avoidance of catastrophizing, is a basic component of interdisciplinary pain programs today.

The Anatomical Basis of Pain

The concept that the mind and the body are separable but interconnected, known as *dualism*, is commonly attributed to Rene Descartes. He described the *mind* as a nonphysical substance and distinguished the *mind* from the *brain*, which was physical (Descartes 1641). In his 1649 essay, "The Passions of the Soul," Descartes sought to delineate emotions from physiological processes and reductionistically compared the human body to a watch:

> . . . the difference between the body of a living man and that of a dead man is just like the difference between, on the one hand, a watch or other automaton (that is, a self-moving machine) when it is wound up and contains in itself the corporeal principle of the movements for which it is designed . . .; and, on the other hand, the same watch or machine when it is broken and the principle of its movement ceases to be active (Descartes 1664).

The philosophical mind-set of *mechanism*, suggesting that the human body functions as a simple machine, with pain being the result of its malfunction (Sawda 2007) was the outcome. This idea, the extension of which informs much of our current day scientific inquiry and clinical practice, had been evolving slowly over time and ultimately superseded more traditional philosophical and theological explanations of pain. Beginning with the early anatomical studies of Galen of Pergamum (130–201 AD) and Avicenna, the Persian polymath (980–1037 AD), evidence for a physical, visible basis of pain developed. During the Renaissance, the zeitgeist of the day encouraged questioning and cultural mores evolved to view science less as religious heresy. This change permitted scientific observation and inquiry, yielding advances in the anatomical, medical, and neurological knowledge. The study of the circulation of blood by William Harvey in 1628 (Harvey 1628), and the direct anatomical studies of Descartes in 1662 (Cranefield 1974) elucidating sensory physiology, became the theoretical basis for further exploration in the 18th and 19th centuries through today (Fig. 1.1).

In the years that followed those early anatomical observations, several important ideas added to our understanding of physiologic pain, including the specificity theory, pattern theory, summation theory, and gate theory.

Descartes described the concept of a pain pathway and theorized the transmission of pain signals, as illustrated in Fig. 1.2. Nearly 150 years later, Charles Bell in Scotland proffered the *specificity theory*. Specificity theory, the seminal concept that pain has a dissectible and demonstrable anatomical basis, and that individual sensory nerves exist and are specialized to perceive and transmit information from an individual stimulus type, cleared the initial path for considerable subsequent experimentation (Bell 1811). Bell discovered that ventral root stimulation caused motor contraction. In 1839, Johannes Muller advanced the idea of specialization of nerve fibers, considering the sensation of sound to be the "specific energy" of the acoustic nerve and the sensation of light the particular "energy" of the visual nerve (Muller 1839). In 1858, Moritz Schiff demonstrated a reproducible loss of tactile and painful sensation resulting from particular lesions of the spinal cord. In 1882, Francois Magendie demonstrated that sensory function occurred via stimulation of dorsal nerve roots (Bell 1811,

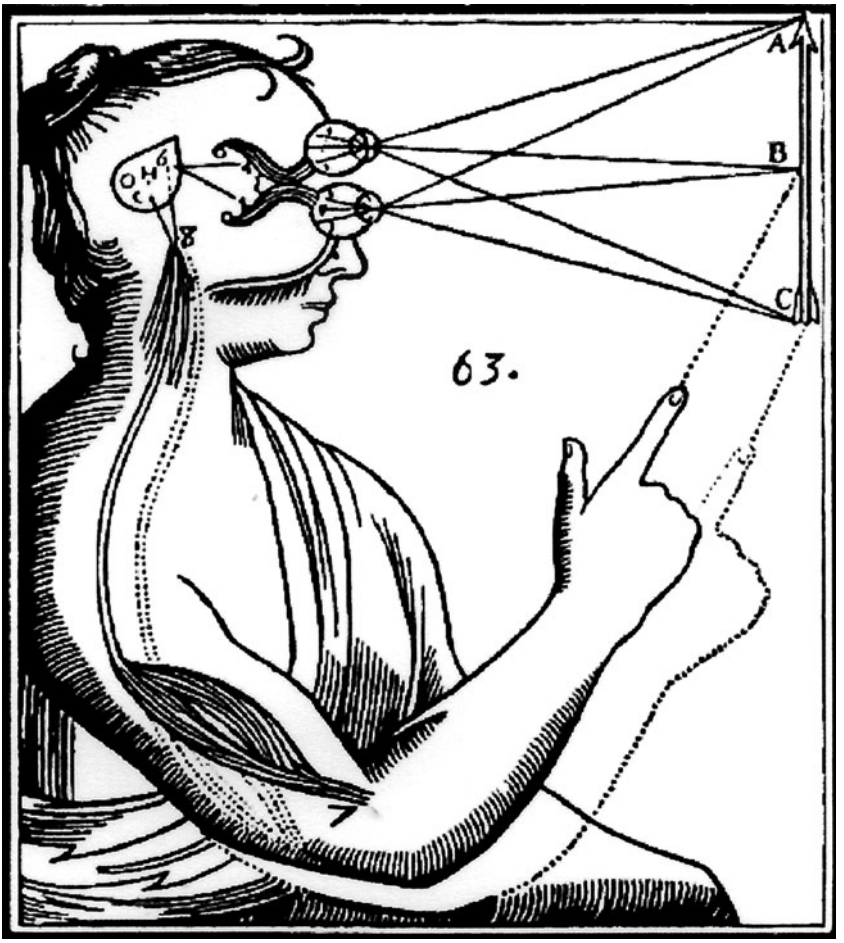

Figure 1.1 Rene Descartes (1596–1650) described the first systematic accounts of the mind/body relationship and mechanisms of action of sensory physiology. In this drawing, he depicts light entering the eye and forming images on the retina. Hollow nerves in the retina would then project to the ventricles, stimulating the pineal gland to release animal spirits into the motor nerves to initiate movement.

Magendie 1822). Ultimately, the sum of these and other discoveries was the specificity theory's advancing the idea of specific pathways and specific receptors for pain that continues to inform our thinking today.

The *pattern theory* was introduced by Alfred Goldscheider, a German army physician, in 1894. This theory proposed that particular, reproducible patterns of nerve activation were triggered by a summation of sensory input from the skin in the dorsal horn. Prior to this time, the skin was believed to be endowed with only one kind of sensation. However, Goldscheider demonstrated that skin contains several distinct perceptive organs. He described three distinct stimuli, pressure, warmth, and cold, and showed that localized points reacted only to a given stimulus and each point had a specific function (Goldscheider 1884). Nafe expanded the pattern theory to the concept that a perceived sensation is the result of spatially and temporally patterned nerve impulses rather than the simple conduction of an individual or specific

Figure 1.2 Descartes reduced reflex nerve function to hydraulic mechanisms, stating, "If the fire is close to the foot, the small parts of this fire, which...move very quickly, have the force to move the part of the skin of the foot that they touch, and by this means pull the small thread... opening the entrance of the pore, where this small thread ends...the entrance of the pore or small passage, being thus opened, the animal spirits in the concavity enter the thread and are carried by it to the muscles that are used to withdraw the foot from the fire."

receptors or pathway (Nafe 1929). Later, the pattern concept was further detailed by Sinclair and Weddell in 1955, who believed that all sensory fiber endings, except those innervating hair follicles, are similar, and it is the pattern of their activation that was felt to be necessary for sensory discrimination (Sinclair 1955, Weddell 1955).

The specificity theory or the pattern theory alone, or in combination could not fully explain many of the clinical observations that have been made about pain. Particularly confounding were the presence of discontinuous pain fields and the capacity for the development of hyperalgesia, the ability to increase pain sensitivity with repeated stimulation. It was also known that pressure sensation over time resulted in increased painful sensation and that pressure points could respond differently to stimulation than did adjacent areas (Perl

2007). Thus, the *summation theory* was proposed to explain these phenomena. Summation theory is based on the idea that there exist multiple interactions between and among neurons, not only within the sensory system, but also including overlap and contributions to pain sensation from internuncial neurons and the autonomic nervous system. The importance of these interactions was demonstrated by Livingstone, Hardy, and Wolff. In 1932, Dr. Charles S. Sherrington was awarded the Nobel Prize in Medicine for his development of the concept of the motor unit, comprised of a receptor, conductor, and effector; and he later identified polymodal receptors and selective excitability. These ideas are central to explaining the anatomy of the summation theory and began to examine the wide array of pain responses and great capacity for neuroplasticity that are well known in the clinical arena. These concepts, which Sherrington initially published in 1906, are still highly relevant today (Sherrington 1906).

In 1965, the ground-breaking *gate theory* was published by Canadian psychologist Ronald Melzack and British physiologist Patrick Wall (Melzack and Wall 1938) and remains a dominant theory in explaining many of the interrelationships seen in pain sensation and perception. Central to this theory is the concept of the presence of a "gate" that either permits or stops the conduction of a given pain signal based on intermodulation and summation of both painful and nonpainful nerve messages, by either turning on or off an inhibitory interneuron. The gate theory permitted the integration of the presence of specific pathways, patterns, and summation of stimuli and provided a paradigm through which to view the more complex interaction between the central and peripheral nervous systems. Despite the fact that many of the specific details of the theory were later refuted, gate control's central tenet of pain modulation through both central mechanisms and competing stimuli has allowed for a more complex understanding of pain and provides the basis for a considerable volume of current day research as well as pain therapy.

The Treatment of Pain

Clinically, pain can be described as a complex construct, integrating the physiologic, mechanical, and neurochemical responses with the social, behavioral, and psychological responses to noxious stimuli. It is therefore necessary to recognize myriad approaches to the treatment of pain and to assess and treat the patient within a larger biopsychosocial view. The choice of a given course of therapy for pain, therefore, is often more dependent on the beliefs of the caregiver and the prevalent world view of his/her place and time. Through history and continuing today, pain therapies have ranged from religious and spiritual practices, cognitive approaches, behavioral therapies, and pharmacotherapy, to highly anatomically specific treatment.

Physicians have long sought to categorize and form systematic means of understanding and addressing pain through the listing and classification of its causes. For example, during the time of the Roman emperor Trajan, who reigned from 98 CE until his death in 117 CE, 13 causes of pain were recorded. Avicenna, a noted Muslim healer and one of the early fathers of modern medicine, in the early 11th century described 15 separate causes of pain. Samuel Hahnemann, the founder of homeopathy, listed 75 (Fulop-Miller 1938). Despite these attempts at organization of pain etiologies, very few specific therapies for painful syndromes were utilized. Prior to the 18th century and the development of anatomical theories that could be clinically implemented in the treatment of pain, many nonspecific therapies were commonly used.

The view of the body as a representation of changes in the natural world, with energetic disproportions envisioned as the etiology of pain, required the development of treatments that would address these imbalances. Examples include the 4,000-year-old practice of acupuncture, which involves the insertion of needles at particular points or along particular meridians, which are then manipulated to either drive energies into or out of the affected system, thereby providing a direct revision of the imbalanced *qi*. Additionally, the application of humoral opposites (see Table 1.2), cupping, blood letting, purging, the use of topical and oral herbal compounds, and distraction by creating a competing, more severe pain, were all employed as means to return balance and alleviate pain.

The English word "pain" is derived from the Latin word *poena*, meaning punishment. It is then unsurprising that an early requirement for the relief of pain was through prayer (Parris 2004). This interpretation clearly reflects the idea of the painful stimulus as being harm inflicted by an omnipowerful presence in response to wrong doing. The iconography of tortured saints, with ecstatic faces, depicted pain as a spiritual discipline, primarily relieved by prayer, meditation, and righteousness.

The relationship between the psyche and the presence and importance of pain is not a new concept. Coping, learning, the role of anxiety, and concurrent psychiatric illness have all been identified as altering pain perception and success of pain therapies. In the 20th century, many new ideas in psychology emerged, which directly affected how pain is treated today. During World War II, Henry Beecher astutely noted that on the battlefield, seriously wounded soldiers reported less pain than civilian patients in the Massachusetts General Hospital recovery room. However, at a later time these same patients would complain vehemently about even minor physical insults. These observations caused Beecher to conclude that the experience of pain was derived from a complex interaction between physical sensation, cognition, and emotional reaction (Beecher 1946). In the 1950s, based on Freudian ideals, the link between psychiatric illness and pain was explored by Engel. By the mid-1960s, it was confirmed that chronic pain patients also often had coexisting psychiatric disease (Engel 1959) and behavior and cognitive therapies were emerging as rational alternatives to more traditional psychoanalytic thought.

The advent and advancement of pharmacological approaches to pain ultimately revolutionized the physician's capacity to provide a therapy that could yield direct relief. While pain-relieving drugs are alluded to in the writings of many ancient societies, the modern pharmacological treatment of pain has been mostly influenced by the cultivation of opioids. While it is not known precisely when in history the opium poppy was first cultivated, it is believed that the Sumerians isolated opium from its seed capsule by the end of the third millennium BCE and that its use spread along trade routes. Beginning in the 16th century, opioid abuse was identified in Turkey, Egypt, Germany, and England. Famously, Thomas Sydenham concocted the recipe for laudanum, consisting of opium, sherry, wine, and spices, in the mid-17th century, and it was quickly and widely employed to treat a broad range of ailments, from dysentery to hysteria and gout. In 1806, the active ingredient in opium was identified by Serturner, who dubbed it *morphine* after Morpheus, the god of dreams. Soon after, codeine was isolated (Brownstein 1993). Without the ability to inject medications, the routes of convenient administration of drugs were limited. This was revolutionized in the 1850s, following the development of the hypodermic needle by Rynd (1845) and the syringe by Wood (Mann 2006). In the years that followed, accompanying increased medicinal use of opiates,

many attempts were made to synthesize a more potent, safer, less addicting alternative to morphine, yielding the development of heroin in 1898 and methadone in 1946 (Brownstein 1933).

Other classes of drugs still in use today take their roots in traditional medicines of antiquity. In South America, coca leaves were traditionally used as a remedy for altitude sickness, physical pain, and as a topical anesthetic. From the coca plant, the alkaloid anesthetic cocaine was isolated by Albert Niemann in the 1860s. Niemann touted the use of cocaine as a cure-all, including for treatment of alcohol and morphine addiction (Niemann 1860). Soon after, in 1884, Carl Koller demonstrated the local anesthetic effects of cocaine (Koller 1884). Additionally, nonsteroidal anti-inflammatory drugs are known to have been used in the form of myrtle leaf, a natural source of salicylates, by the ancient Egyptians. By 200 BCE willow bark, another natural source of salicylic acid, was in use by Greek physicians; however, the first scientific report of the power of willow derivatives was not published until 1763 by the Reverend Edmund Stone (Leake 1975). Salicylic acid was identified as the active ingredient in willow leaf extract by the French pharmacist Henri Leroux in 1829. A more palatable and well-tolerated version of the drug was prepared by Charles von Gerhardt in 1873 with the addition of an acetyl group, synthesizing what is commonly known today as aspirin (Fairley 1978). Quickly thereafter, in 1899, aspirin was registered and marketed by Bayer.

As the adage goes, "a chance to cut is a chance to cure," requiring that the medical caregiver believes that the nature of a pain lies in the body. Inspired by specificity theory and its derivatives, more and more refined specific anatomical treatments were developed for the treatment of pain, in both the peripheral and central nervous systems. Multitudes of surgical approaches to pain have been employed, predominantly based on the tenet of interruption of a specific path of sensory conduction, including neurotomies, dorsal root excision, thalamectomy, mesencephalic lesioning, psychosurgical lobotomies, and other procedures specifically designed to alter the anatomy and interrupt pain signal reception.

In addition to open surgical procedures, direct interventional approaches to the disruption of pain signals developed. As early as 1784, James Moore, a British surgeon, demonstrated that the compression of specific nerves could provide reversible surgical anesthesia, thereby piloting regional nerve blockade (Moore 1784). However, the use of injection of neurolytics to provide long-lasting interruption of nerve conduction was not performed until 1903 by Schloesser (1903). Later, in response to patients with sympathetic nerve injuries in World War I, René Leriche developed the technique of injecting the local anesthetic procaine and surgical sympathectomy, which later became a standard therapy (Leriche 1937). In the 1920s, nerve ablation procedures became a treatment of choice, even for chronic unexplained pain syndromes, cementing the role of nerve blocks, and in 1936, at Bellevue Hospital in New York City, the first nerve block clinic for pain management was established (Rovenstine 1941).

While electrical modalities for pain relief were used by the ancient Egyptians, Greeks, and Romans, typically by means of medical use of electric fish, the underlying explanation of how electricity caused pain relief was not explained until gate control theory became a part of the pain practitioner's lexicon (Sabatowski et al. 1992). Modern extrapolations of gate control theory now include implantable dorsal column stimulators, transcutaneous electric nerve stimulation (TENS) units, and deep brain stimulation.

The Specialty and Future of Pain Medicine

While ever finer and more targeted anatomical treatment for pain continues to become more prevalent, it is important to recognize that perhaps the greatest advance in modern thinking about pain medicine has come not in the form of choosing a single modality or approach or pain concept, but rather is the recognition that multiple pain theories, anatomical processes, and therapies must coexist. Although this joining of previously dichotomous thinking has been advocated for some time, as recently as a decade ago, French sociologist Isabelle Baszanger noted the presence of two disparate types of pain clinics in Paris: one based on "curing through techniques" and the second based on "healing through adaptation (Baszanger 1992)." Rather than our making a choice between the mind and the body, a holistic concept of patient-centered pain management has emerged. Initially this was devised by the mother of hospice medicine in Great Britain, Dame Cicely Saunders, through her idea of "total pain (Clark 1999)." After his experiences treating the pain of World War II veterans, the founder of interdisciplinary pain care, Dr. John Bonica, organized an early large-scale multidisciplinary conference of 300 clinicians and researchers, which ultimately gave rise to the International Association for the Study of Pain (IASP) (Liebeskind 1997). Now, more than 60 scientific disciplines are represented by the IASP. This multidisciplinary trend has continued with the establishment of formal subspecialty Board certifications in Pain Medicine through the American Board of Anesthesiology in 1991, followed by subspecialty certification from the American Board of Psychiatry and Neurology (ABPN) and the American Board of Physical Medicine and Rehabilitation (ABPMR) in 2000 (Fishman et al. 2004). Currently, in the United States, the expectation and preference of interdisciplinary pain care has impacted the training of physicians, and the Accreditation Council for Graduate Medical Education established new guidelines to provide for multidisciplinary pain education as a requirement for subspecialty pain fellows in 2007 (Official website of the ACGME 2008).

Pain is essentially so much a part of our common humanity and so central to the practice of medicine that without understanding of the assessment, diagnosis, and treatment of pain, our care of patients would be woefully inadequate. The dramatic breadth and depth of the field of pain medicine makes it a fertile ground for future innovation. In every aspect of pain care, from the subcellular to the community-wide level, advances are being made that not only influence theory but also practice. The rapid current acceleration in molecular biology, genetics, imaging modalities, and high technology provides constantly growing potential for discovery. At the same time, renewed interest in old world ideas and techniques encourages the development of the art of healing among caregivers. It is the goal of this chapter to provide a mental framework to understand the evolution of our current concepts and therapy for pain and to foster professionalism in this newly emerging and exciting focus of scientific and clinical study.

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