Genesis of chronic pain

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Abstract

The theories behind the evolution of the genesis of chronic pain are explored from a historical perspective. The major focus of the article explores the biomedical and the psychosocial factors that contribute to the genesis of chronic pain in particular how the physical and psychological interact together. Risk factors and pre-existing determinants are discussed.

Keywords Biomedical; chronic; genesis; pain; psychosocial; risk factors; theories

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Learning objectives

After reading this article, you should be able to:

- describe the history of the theories of pain
- know the current definition of pain
- explain the concept of the biopsychosocial model of pain
- discuss the biomedical models linked to the genesis of pain
- discuss the psychosocial models linked to the genesis of pain

"Pain is inevitable. Suffering is optional"

(Bhuddist proverb)

The International Association for the Study of Pain (IASP)[1] in 1986 defined pain as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of tissue damage or both'.

Pain has been described since time immemorial. In the book of Genesis in the Bible, we read that Eve was told: *'I will make your pains in childbearing very severe; with painful labour you will give birth to children'*. Few of us, if any, will escape without some experience of prolonged pain during our lifetimes. For some people, however, pain becomes a chronic, intractable state that has a significant impact on their quality of life.

The word pain itself derives from the Latin *poena*, meaning 'penalty.[2]' This reflects the tradition of pain being seen as a kind of punishment or test of faith inflicted upon mankind. In Ancient Greece, Plato and Aristotle both looked upon pain as being an emotional rather than a sensory experience, something that was experienced by the human heart. Aristotle believed it to be like a spirit that enters the body through an injury.

In 1664 Rene Descartes[2] wrote the Treatise of Man wherein he traced the pathway of pain. His depiction of the young man holding his foot close to a fire is one we are all familiar with. His understanding was that perceived pain to the brain travelled in only one pathway – the same pathway used by other sensations.

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In 1811, Charles Bell put forward the **Specificity Theory** – he proposed that nerves had different functions and that the brain was not a homogenous structure as had been proposed by Descartes. The implication was that pain messages travelled via a specific pathway, whereas other sensations travelled by other pathways unique to each sensation. Francois Magendie in 1856 went on to describe the specific organization of nerves within the spinal cord. This theory was challenged initially as it went against the teachings of Aristotle that pain was an emotion and a quality of all senses. In 1894 von Frey postulated that there were four sensory modalities one of which was pain, a theory further reinforced by Goldsheider and Blix who described specific skin spots which if stimulated would cause pain. In 1906, Sherrington described the term nociceptor and further endorsed the Theory of Specificity of pain.

The **Intensity Theory of Pain**[2] was first described by Plato in the fourth century BC where he described how pain occurred as an emotion when there was a stronger stimulus than normal. In 1794 Darwin described a similar concept in 'Zoonomia' only to be followed 100 years later by Erb who reiterated that pain occurred when a sensory stimulus reached a specific intensity rather than being secondary to a specific pain stimulus. In 1929, Nafe postulated the **Pattern Theory** of pain – proposing that it was the pattern in which way a stimulus occurred that led to pain.

In 1965, Melzack and Wall,[3] the fathers of modern pain medicine, proposed the **Gate Theory** of pain – a theory that linked the Specificity and Pattern theories. They described the presence of nociceptors as well as touch receptors. These led to nerve fibres which synapsed within the dorsal horn of the spinal cord and in the substantia gelatinosa, the latter acting as a gate in the spinal cord. Thus when the painful signal reached a specific intensity, the gate opened and activated pathways which led to pain being experienced. They also proposed that fibres coming down from the brain could also determine when this 'gate' opened.

In 1968, Melzack and Casey[3] went one step further to describe pain in a multi-dimensional way, describing sensory-discriminative, affective-motivational and cognitive-evaluative components. This ethos is encompassed in the IASP modern definition of pain and is the cornerstone of the **Biopsychosocial model of pain**.

The biopsychosocial model of pain

To understand the biopsychosocial model in pain it is imperative to appreciate the difference between nociception and pain. *Nociception* is defined[1] as the stimulation of nerves conveying

information about tissue damage to the brain, while pain refers to the subjective experience resulting from transduction, transmission and modulation of nociception and its complex interactions with genetics, previous history of pain, current mood state and surrounding socio-cultural environment.

It is also essential to underline the difference in the presentation and characteristic features of acute and chronic pain.

Acute pain has a recent onset and usually has a variable but short duration. As a response to injury or tissue damage, it decreases in intensity as the healing process sets in. It can also be present without injury or tissue damage as in exercising skeletal muscle.

The time course of pain and healing can, in most cases, be reasonably predicted based on the site, cause and nature of injury or disease. Tachycardia, increased peripheral blood flow and blood pressure, increased muscle tension and sweating secondary to autonomic hyperactivity accompany acute pain states in a similar fashion to that seen in anxiety states.

Chronic pain is the occurrence of persistent pain over a period of time that goes beyond time associated with natural healing – arbitrarily defined by some authors as 3–6 months. It is less amenable to alleviation by conventional medical treatment. Anatomical, physiological, and biochemical pathology identified by physical examination and diagnostic tests do not always adequately explain the persistence of chronic pain. Unlike the autonomic hyperactivity seen in acute pain states, patients with chronic pain tend to exhibit neurovegetative symptoms – altered appetite and weight, disrupted sleep, decreased energy and libido, diminished concentration and increased irritability.

The characteristic feature of chronic pain is that non-noxious stimuli such as normal day to day activity become painful. Pain perception is modified by the patient's emotional status – depression, anxiety and anger can all impact on this perception. It can be modified by higher cognitive functions including previous experiences, beliefs and expectations. A woman facing labour pain for the second child is more likely to be anxious and have a heightened response to pain, if she had faced a complicated labour the first time round. A footballer who fractures a foot with potentially life-changing career implications is more likely to have a heightened response to pain, than another person in a routine job where such a fracture may be perceived more as a temporary nuisance rather than a permanent disaster.

Such patients usually have tried and failed various medical and surgical treatments targeted towards relief of their pain symptoms. The ensuing emotional distress, impact on family and socio-economic status become significant problems in their own right.

The conventional biomedical model narrowed pain to the dichotomy of physiological or psychological origin. Any pain response that did not correlate with the degree of tissue damage was considered 'unreal' or psychological. It was too rigid to explain the complexities of chronic pain.

George Engel[4] is credited with the introduction of the biopsychosocial model of illness. In contrast to the biomedical model, he put forward the theory that illness results from a complex interaction between various biological, psychological and social factors. Subsequently, Loeser applied this model to pain. Fordyce's work on behavioural pain management interventions cemented the role of psychosocial and physical therapy interventions for chronic pain management. All of this, culminated in a biopsychosocial model of interdisciplinary care, incorporating physical treatment with cognitive, behavioural, environmental, and emotional interventions. From this emerged four dimensions related to the idea of pain: nociception, pain, suffering, and pain behaviour.

The Neuromatrix Model of Pain, proposed by Melzack[5] in 1999, carried this forward by introducing the stress component into the pain equation. According to this, each individual's unique neuromatrix—comprised from genetics, sensory modalities and memory—determines the overall interpretation of the experience of pain.

Biological factors implicated in the genesis of pain

Biological factors may be responsible for initiating nociception as well as maintaining and modulating the pathophysiological changes in the genesis of pain.

Gender

Despite the fact that women are more likely to lead healthier lifestyles and to seek medical help earlier, several acute pain states such as post-surgical and procedural pain as well as chronic pain conditions such as back pain are commoner in women than in men. Although psychosocial factors are implicated, there is also evidence[6] to suggest that there is a gender difference in the response to painful stimuli. Sex hormones also affect pain perception, with evidence showing that women have different pain thresholds and sensitivity during different parts of the menstrual cycle. There is also evidence to support a difference in μ receptor activity in the two genders.

Genetic factors

The genome of each individual influences the basal sensitivity of pain, the likelihood of developing chronic pain conditions and also the response of the body to pharmacological analgesic agents. Various genes[7] have been mooted including those coding for opioid receptor μ 1 receptors, the catechol-O-methyl transferase enzyme, multi-drug resistance gene (MDR1) transporter proteins, the melanonocortin-1 receptors, guanosine triphosphate (GTP) cyclohydrolase, enzymes that metabolize analgesics, and various genes encoding substances involved in the immune system.

Disease processes: nociceptive and neuropathic pain

Malignancy, trauma, auto-immune disorders, infection and ageing all share some common features in terms of generation and exacerbation of nociceptive pain. Tissue inflammation leads to the release of chemical mediators including prostaglandins, leukotrienes, proteinases, neuropeptides and cytokines into tissues which in turn stimulate primary afferent nerves such that activities which can normally be done without pain, become painful.[8] This is the underlying neurophysiological basis of **allodynia** defined[1] as 'the triggering of pain by stimuli that would normally not cause pain' and **hyperalgesia** defined[1] as 'an increased sensitivity to pain'. Thus when a painful stimulus induces active inflammation, the sensitized area spreads and with this additional neurons are also activated. This leads to a lower pain threshold and a further increase in the sensitivity of adjacent neurons.