

# PAIN AND AGING

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In recent decades, progress has been made in understanding pain mechanisms, both peripherally and centrally. The gate control theory, with its emphasis on psychological influences on pain perception, has revolutionized the way pain is viewed and managed. Yet, understanding certain aspects of pain mechanisms remains elusive. Although experimental studies of the effects of aging on pain thresholds are inconclusive, there is a trend toward lower pain tolerance and greater sensitivity to pain in the elderly. Given the widespread misconceptions and attitudinal problems related to pain in the elderly, the barriers to accurate assessments and effective management of pain need to be overcome. Unnecessary suffering for the elderly needs to be minimized, to promote their quality of life and enable them to maintain their functional abilities longer.

*Key words:* Pain, aged, pain theory, quality of life, dementia

Pain is a common and serious problem in the elderly. Up to 80% of older adults have at least one chronic health problem which may cause pain,<sup>1</sup> e.g. osteoarthritis, skin ulcers, osteoporosis, cancer, angina, diabetic neuropathy, chronic infections, Parkinson disease, and injuries.<sup>2-4</sup> The common problems associated with pain are reduced function, depression, impaired mobility, sleep disturbance, anxiety, and diminished quality of life.<sup>5-7</sup>

In hospital, 78% of elderly patients experienced pain, and 71% of nursing home residents complained of pain.<sup>5,8</sup> In a random survey of 500 households, morbidity associated with pain was about two times greater in subjects >60 (250 per 1000) compared to subjects <60 (125 per 1000).<sup>9</sup> Over 75% of elderly recipients of home nursing services reported that they experienced pain in the 2 weeks before the interview.<sup>6</sup>

This paper examines the relationship between pain mechanisms and aging. The specificity and gate control theories of pain are reviewed, particularly as they affect pain management. The effects of aging on these pain mechanisms and the misconceptions and attitudes that act as barriers to accurate pain assessment are discussed.

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## PAIN THEORIES

To detect and manage pain in older adults, an understanding of the mechanisms of pain is useful. Major advances in knowledge of pain mechanisms have occurred in the past few decades. **The specificity theory of pain**, which originated in the early 19th Century with Descartes, was one of the first attempts to understand pain. The concept of a pain pathway linking the periphery and higher centers in the brain was later developed as the “law of specific nerve energies”, meaning that “particular nerves subserve special functions for which they are specifically adapted”.<sup>10</sup> It is postulated that, after body tissue injury, peripheral sensory receptors are stimulated, eliciting a pain impulse which travels via the spinal cord through the thalamus, to sensory areas of the brain. The amount of pain experienced is related to the amount of tissue damage. A key aspect of this theory is that pain is represented in the brain by a one-to-one correspondence with specific nerve fibers from certain parts of the body.<sup>4</sup>

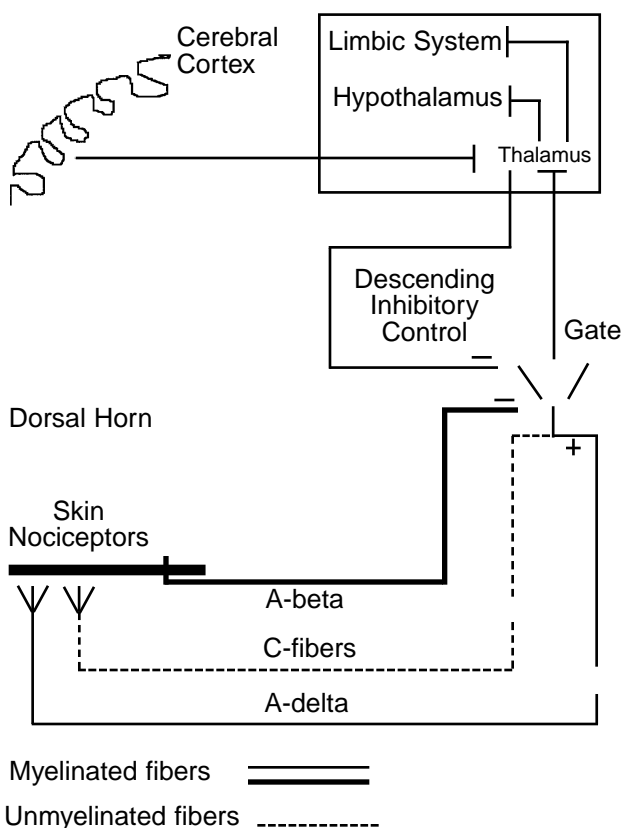
With this simple theory of pain, management is limited to biophysical approaches, using surgical and pharmacological interventions to interrupt the pain impulse. While these interventions have proved helpful in the management of acute pain, they have not been as effective in chronic pain.

**Melzack and Wall’s gate control theory** is built on the specificity theory in an attempt to incorporate other factors (sensory, motivational, affective, and cognitive) that influence pain perception and response.<sup>11,12</sup> This theory offers a framework for understanding and managing the interactions that occur in acute and chronic pain. This theory explains the influence of various factors (e.g., cultural differences, past experience, family attitudes, depression, anxiety, distraction, and placebo) on pain perception. The gate control theory provides an explanation for the variability in pain perception among individuals that is not explained by the specificity theory.

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According to Melzack and Wall, the principal structures in the nervous system involved in pain perception are: skin receptors, peripheral nerves, spinal cord neurons and their associated fiber tracts, the thalamus, limbic system, and the cerebral cortex (Fig. 1). Skin receptors that respond to pain stimuli, called *nociceptors*, are terminals of myelinated A-delta nerve fibers that transmit immediate, sharp pain sensation, and smaller unmyelinated C-fibers that transmit slower, dull pain sensations. The larger, myelinated A-beta nerve fibers also transmit other sensory impulses.

After nociception, an impulse travels via the peripheral nerve tract to the substantia gelatinosa in the dorsal horn of the spinal cord. In this area, there is a gating mechanism, where pain impulses can be modulated in various ways. Stimulation of the large A-beta fibers inhibits transmission (closes gate), while stimulation of the smaller A-delta and C-fibers facilitates transmission (opens gate). Inhibitory control impulses from the brain involve the interaction of multiple brain centres (e.g., reticular formation, thalamus, limbic system, cerebral cortex), transmitting information relating to



Adapted from: Escobar P. Management of chronic pain. Nurse Pract 1995; 10: 24-31.

Fig 1. The Gate Control theory

attention, past experiences, emotional states, and behaviours of a painful experience that affect the gating mechanism. This theory does not explain exact details of these interactions, and certain painful conditions elude explanation by the gate control theory (e.g., phantom limb). Nonetheless, this theory explains the association between psychological and cognitive variables and the perception and modulation of pain.

The management of pain has been influenced by the gate control theory.<sup>4,12,13</sup> Cutaneous stimulation techniques (e.g., massage, rubbing, heat and cold therapies) are used to control pain, since these techniques stimulate the large A-beta fibers, which close the “pain gate” and counteract pain impulses transmitted by other, smaller nerve fibers. Distraction and imagery techniques are used to reduce pain by increasing sensory input from the brainstem and exerting an inhibitory influence on the spinal gate-control system and higher brain systems.

Interventions that increase a person’s sense of control over their pain are also supported by the gate control theory.<sup>4,13</sup> Education and effective coping techniques (e.g., relaxation, use of pain medication) and participation in pain-inducing activities (e.g., debridement of burn tissue) can offer individuals a sense of control over their pain. Although the exact mechanisms are unclear, achieving a sense of control can diminish both anxiety and pain by transmitting inhibitory impulses from the cerebral cortex and thalamus.<sup>12</sup>

Despite shortcomings, the gate control theory explains some of the physiological and psychological mechanisms associated with pain perception and provides a scientific rationale for the development and implementation of various pain management techniques to reduce pain. What is the effect of aging on these pain mechanisms and pain sensitivity?

### EFFECTS OF AGING ON PAIN SENSITIVITY

We performed a literature review to determine the effect of aging on pain threshold and pain tolerance (Table 1). **Pain threshold** is defined as the lowest stimulus value at which the person reports that the stimulation feels painful, whereas **pain tolerance** is the lowest stimulus level at which the subject withdraws or asks to have the stimulation stopped.<sup>12</sup>

Most of the studies reviewed measured pain thresholds using thermal methods (e.g., hand-held contact-thermode, radiant-heat produced by a projection lamp that focuses on skin blackened with ink) on various sites of the body (e.g., hand, forearm, forehead, sole of foot). The majority of studies

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showed a general increase in pain thresholds and decrease in pain sensitivity for the elderly.<sup>14,19,24,25</sup>

In aging, thin skin may increase dispersion of thermal energy and/or increase nociceptor thresholds, which may have confounded these studies and explain why pain thresholds appear higher.

In addition to thermal methods, other noxious stimuli have been used to measure pain thresholds in older adults. The results of these studies are inconsistent. Studies of pain threshold in young and older adults using electrical stimulation of healthy, unfilled teeth revealed no significant differences in threshold between young and elderly.<sup>17,18</sup> The elderly were poorer at discriminating between low and high intensity levels, suggesting a possible age-related deficit in the central nervous system.<sup>22</sup>

Other studies using electrical and mechanical stimulation found that pain thresholds increased with age.<sup>21,22,29</sup> Elevated pain thresholds in the elderly may be due to age-related slowing in the cognitive processing and reduced cortical activation.<sup>30</sup> This may explain

the reduced ability of older adults to discriminate differences in pain intensities and a “reaction time slowing” of the cognitive processes used to discriminate pain. The elderly feel the pain but need more time to report it compared to younger individuals. Further research is needed to examine effects of aging on pain mechanisms, especially at the cortical level.

Age-related effects on the functioning of both the C and A-delta nerve fibers have been proposed. The integrity of the C-fibers is assessed using the axon reflex flare; larger flares are associated with greater pain.<sup>20,31</sup> Using capsaicin as a chemical stimulant, older adults had a decreased flare response compared to younger individuals, suggesting a decrease in (1) the collateral nerve network and/or (2) the distribution of each innervated vessel in the skin.<sup>20</sup> However, the effects of aging (e.g., thinning of skin, variable skin temperature) may contribute to the reduced flare response, so these results should be interpreted with caution.

Recently, the functioning of the A-delta fibers and

**Table 1.** Age and sensitivity to pain

Reference	Noxious Stimulus	Sample	Pain Threshold	Pain Tolerance	Other Relevant Findings
Chakour et al, 1996 <sup>14</sup>	Thermal	n = 15 young (20-40 yrs)  n = 15 elderly (65 - ? yrs) mean:74.1 yr	• increase with age	—	• age-related change in A-delta fiber-mediated epicritic pain perception
Collins & Stone, 1966 <sup>15</sup>	Electrical	N = 56  20 - 54 yrs	• decrease with age	• decrease with age	
Hardy et al, 1943 <sup>16</sup>	Thermal	N = 200  10 - 80 yrs	• no differences	—	
Harkins & Chapman, 1976 <sup>17</sup>	Electrical → tooth	N = 20 healthy men	• no differences	—	• age-related increase in response bias • elderly less accurate in discriminating pain intensity → anxiety scores higher also
Harkins & Chapman, 1977 <sup>18</sup>	Electrical → tooth	N = 20 healthy women  20-81 years	• no differences  • decrease threshold for intense pain	—	•age-related increase in response bias for mild noxious stimuli
Harkins et al, 1986 <sup>19</sup>	Thermal	N = 44 volunteers  20-80 years	• slightly elevated for elderly	—	
Helme & McKernan, 1995 <sup>20</sup>	Chemical	N = 220  17 - 84 yrs (estimated using scatter diagram)	—	—	• flare response increases with age → may be associated with skin thickness

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**Table 1.** cont'd. Age and sensitivity to pain

Reference	Noxious Stimulus	Sample	Pain Threshold	Pain Tolerance	Other Relevant Findings
Kenshalo, 1986 <sup>21</sup>	Mechanical → tactile & vibration  Thermal	n=27 young  n=21 elderly 19-84 yrs	• increase to mechanical • no difference for thermal	---	
Neri & Agazzani, 1984 <sup>22</sup>	Electrical	N = 100 20 - 82 yrs	• increases with age	• no differences	
Notermans, 1966 <sup>23</sup>	Electrical	N = 30 10-65 yrs	• no differences		• representation of older population not known
Procacci et al, 1974 <sup>24</sup>	Thermal	no data available	• increase with aging	---	• changes in physical qualities of older person's skin (e.g., thinning) can increase pain threshold
Sherman & Robillard, 1960 <sup>25</sup>	Thermal	N = 200 20 - 97 yrs	• increases with age	---	
Tucker et al., 1989 <sup>26</sup>	Electrical	N = 520 5-105 yrs	• increases with age	---	
Walsh et al., 1989 <sup>27</sup>	Cold Pressor Test	n = 500 healthy volunteers  n = 113 patients with chronic pain  18-87 years		• decrease with age	
Woodrow et al., 1972 <sup>28</sup>	Mechanical → pressure on Achilles tendon  "deep pain"	N = 41,119  <20- 70+ yrs  *only 4% of sample 70+		• decrease with age	

its relationship to aging, have been studied using a nerve compression block of the A-delta fiber. Younger individuals had significant increases in thermal pain threshold (decreased pain sensitivity), while pain thresholds remained relatively stable in the elderly, suggesting that there is an age-related decrease in the A-delta fiber function in pain perception.<sup>14</sup> It is possible that aging may affect C and A-delta nerve fibers in the perception of pain.

In addition to pain threshold, pain tolerance is also used as a means to determine pain sensitivity. Four studies reviewed examined the effects of aging on pain tolerance. Three showed decreased pain tolerance in the elderly compared to younger individuals.<sup>15,27,28</sup> These studies of pain tolerance and aging indicate that the elderly are generally more sensitive

to painful stimuli than younger individuals.

*In summary*, although the results from the pain tolerance studies indicate a trend towards greater pain sensitivity in the elderly, this trend is not supported by the pain threshold studies. The results of the studies on pain sensitivity are inconsistent, and conclusions from other reviews are also inconsistent.<sup>30-34</sup>

### CRITICAL ANALYSIS OF PAIN SENSITIVITY STUDIES

The inconsistencies among the studies reviewed, particularly those relating to pain threshold, could be due, in part, to the varied methods used (e.g., thermal, electrical, mechanical), the amount and duration of noxious stimulation, and sampling biases (e.g., paid volunteers). Although these studies

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were conducted in controlled laboratory settings, many possible variables, such as personality type, culture, and sex of the subjects, were not controlled. The results of these experimental studies cannot be applied easily in the clinical setting. These experimental studies tend to oversimplify the acute and chronic pain experience and neglect important psychological and emotional factors.<sup>20</sup> Moreover, the anticipation of an unfamiliar painful experience using strange equipment may influence a subject's perception and response to pain.

The cognitive-evaluative component is affected by the setting and can affect the way pain is perceived. The meaning of the situation has tremendous impact in the way pain is experienced, e.g. civilians who sustained injuries less severe than soldiers, complained of more intense pain and required more morphine to alleviate their pain than the soldiers.<sup>36</sup> The soldiers either denied their pain or had so little that they refused any pain medication. Pain for the soldier was caused by a nonfatal injury, which meant that they escaped alive from the battlefield. Pain for an older person has different implications, such as the need for institutionalization or impending death. In an attempt to deal with these fears, the elderly may elicit higher pain thresholds or even deny mildly-induced pain.

Another factor that affects the pain experience may be related to an older person's history of accumulated life experiences. Old age is characterized by chronic pains which lost their "newness" sometime in the past,<sup>1</sup> e.g. older persons who have suffered from chronic pain for a large part of their life, may perceive the laboratory-induced pain differently than those who are relatively pain-free; chronic pain, may "desensitize" older adults to additional pain experiences. On the other hand, individuals who suffer from chronic pain may be more sensitive to pain because of their exaggerated focus on the painful stimulus.<sup>36</sup> This is consistent with the conclusion drawn from our analysis of the pain tolerance studies in this review, that the elderly are more sensitive to pain than younger individuals. The elderly constitute a unique group of individuals who may respond differently than their younger counterparts when asked to respond to the exact time when "the stimulation feels painful".

In light of the gate control theory, the motivational, affective and cognitive-evaluative components of pain need to be systematically examined in the elderly, noting their influence on reported pain sen-

sitivity. In this manner, an accurate consistent representation of the age-related effects on pain sensitivity can be determined.

The experimental studies relating to the effects of aging on pain sensitivity, have been conducted to increase knowledge and challenge common misconceptions about aging and pain; although the research findings are inconsistent, the "differences appear less important than the similarities".<sup>37</sup> The consequences of treating a person without pain seems less devastating or harmful than not treating a person with pain.

A common misconception is that pain is a normal consequence of aging. The elderly may be reluctant to report pain, attributing pain to old age. Because of this belief, pain in the elderly is frequently accepted by patients and health-care providers as a normal part of the aging process and left untreated.

Another attitudinal problem among health-care professionals that may preclude accurate assessments of pain is the tendency to discount or even disbelieve persons when they complain.<sup>38</sup> As patients' complaints of pain increased, nurses were increasingly likely to judge the pain as exaggerated, and nurses documented less than 50% of the pain that patients described.<sup>39,40</sup>

## PAIN IN DEMENTIA

A common belief of for the elderly health-care professionals is that dementia patients do not feel pain. There is growing concern that older adults with dementia who suffer pain are underdiagnosed and undertreated. Cognitively-impaired older adults may not complain of pain and may have atypical responses to pain. Anecdotal observations of dementia patients walking shortly after hip surgery have led some health-care professionals to question the validity of pain experienced by these patients. This apparent 'pain-free' state could be explained by a damaged "pain centre" in the brain or an interruption in the fixed direct pain pathway, caused by dementia.

Increased knowledge of pain mechanisms based on the gate control theory, reveals that these speculations are wrong. The idea of a single "pain centre" is refuted, because there are a host of complex connections of neural synapses in various areas of the brain that travel in multiple pathways, rather than a single, direct route. The psychological variables of pain perception may be different in cognitively-impaired people, since dementia affects multiple higher cortical functions, including memory, think-

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ing, orientation, comprehension, learning, emotional control, social behaviour and motivation.<sup>41</sup>

The impact of dementia on the mechanisms of pain has received little attention because of its complexities. Recently, this area has received growing speculation which should create momentum for more research. There may be a blunting of physiologic responses (i.e. heart rate) to pain in dementia.<sup>42</sup> Both the experience and reaction to pain are different in cognitively-impaired elderly compared to cognitively-intact elderly. It is unclear if it is the physiological or psychological response to pain (e.g. anticipation, anxiety) that accounts for this apparent blunting of responses.

Attempts to study pain in the elderly with dementia show some progress towards an understanding of this complex issue. Critical questions for research in this area are: Is the atypical response to pain in older adults with dementia due to an interruption of the pain pathway or altered responses to pain? What is the role of memory in the experience of pain for dementia patients? Can they discriminate pain from other sensory information?

The influence of early experience in perception of pain may affect the response to pain in older adults, e.g. dogs who were deprived of normal environmental stimuli throughout life failed to respond normally to noxious stimuli (repeatedly poked noses into a flaming match, endured pinpricks with little evidence of pain).<sup>11</sup> Patients with dementia may respond in a similar manner as a result of memory loss, which decreases their ability to access their accumulated life experiences and appropriate behavioural responses to painful experiences.

Further investigation is warranted to gain a clearer understanding of the unique experience of pain in older adults with dementia. Certain misconceptions and attitudes are barriers to accurate pain assessments and may lead to unnecessary pain and suffering in these older adults.

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