

The Future of Chronic Pain Management: The Importance of Education and an Interdisciplinary
Individualized Patient-Centered Approach

Maria Agustina Padrón

Haverford College

Dedicated to the ladies (Flor, Jackie, Kathryn, and Tere), my dad, and my suitemates for always being supportive and listening to my endless talk about the writing and research process, and chronic pain. A special thank you to the physical therapists I have shadowed that inspired this topic and to my advisor, Shu-wen, and second reader, Becky, for helping guide my writing process and answering my many questions.

Abstract

A systematic review of pharmacological, psychological and physiological approaches to chronic pain management was conducted. Theories that inform the treatment approaches were examined and the evidence supporting individual treatment options found under the categories of pharmacological, psychological, and physiological methods for managing chronic pain were explored. The ending examines the efficacy of each approach and suggests possible solutions to limitations found within the approaches in the form of interdisciplinary healthcare and education of healthcare providers and patients.

Keywords: chronic pain, pain science, interdisciplinary healthcare

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Chapter 1: Introduction

In 2016, the National Center for Complementary and Integrative Health found that approximately 20% of U.S. adults had chronic pain, and 8% had high-impact chronic pain, which was defined as pain that limited at least one major life activity (Dahlhamer et al., 2018). The incidence of chronic pain cost the U.S. an estimated \$560 billion that year in direct medical costs, loss of productivity, and disability programs. The American Academy of Pain Medicine (2011) states that pain affects more U.S. Americans than diabetes, heart disease, and cancer combined, and that chronic pain globally affects more than 1.5 billion people. Chronic pain is a big burden not only on those who suffer from it, as well as their direct family members and friends, but also a big burden financially and through loss of productivity for the United States. With such a high incidence rate, it is important to address the ways that we can mitigate this problem and help people achieve better management of their chronic pain and ultimately better relief from their chronic pain.

Chronic pain is defined as pain that has lasted for over 12 weeks, or approximately over the course of 3 months (Landis, 2011). The American Chronic Pain Association's guide to medical, interventional, behavioral, pharmacologic and rehabilitation therapies (2018) lists a comprehensive guide to chronic pain management – including approved and recommended sources of care and treatment, and experimental treatments for chronic pain. Among those that are recommended sources of treatment are big umbrella categories of medical treatments and nonmedical treatments. Medical treatments include any pharmacological interventions, and nonmedical treatments include any psychological/behavioral treatments and physiological treatments.

In this paper I will attempt to give a broad, yet comprehensive, review of literature concerning the three main branches of treatment that are used to manage chronic pain: pharmacological, psychological, and physiological. I will also give overviews of theories that inform these different approaches. Lastly, I will offer my recommendations for possible solutions to limitations within the three broad approaches for chronic pain management, including an interdisciplinary patient-centered individualized approach to chronic pain and furthering education of individualized pain experiences within the healthcare system.

Chapter 2: Pharmacological Treatment for Chronic Pain

When one thinks of chronic pain treatment, one often thinks of pharmacological treatment. As of 2019, there are more than 200 different types of medication that are used in the management of chronic pain. To narrow down the 200 different types, there are six classes of medication type: antidepressants, nerve pain anticonvulsants, nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, muscle relaxants, and cannabinoids. Of these six classes of drugs, I will talk about the most common drugs used in chronic pain management today, as well as about the combinations of drugs that are most efficacious and most in use. I will begin this section by outlining popular theories and models for how pain is processed - that have to do specifically with pharmacological treatment - in order to have a baseline understanding of how and why the pharmacological approach may work in the treatment and management of chronic pain.

Models for the Pharmacological Approach

General neuroscience of pain: terms and things to know. There are some basic terms that one needs to understand when thinking about the neuroscience of pain. Nociception is a primary objective response to perceived or actual tissue damage, and this response is one that may not always lead to the subjective experience of pain. Nociception happens in response to the

stimulation of nociceptors, or nerves that are used to convey sensory information (Gatchel, Howard, & Haggard, 2011). Sensory receptors (thermal, mechanical, polymodal, and silent) are the primary means through which noxious - harmful or unpleasant - insults to one's system are registered and conveyed to the brain from the outside world (McCaffrey, Frock, & Garguilo, 2003). Neuropathic pain is that which represents actual disease of the nerves that are located in the periphery or in the central nervous system (Gatchel, Howard, & Haggard, 2011).

Biomedical models. There are a couple of biomedical models that help us to understand pain in a neurological and physical sense. These theories of pain describe the subjective experience of pain that one has that results from the conscious awareness of nociceptive sensory processes. This awareness is then assigned meaning after being filtered through an individual's psychological and sociocultural expectations.

One biomedical theory of pain is the specificity theory. This theory relies on the existence of specialized nerve endings that are responsible for transmitting painful information from the outside world (from the skin) to the brain (Gatchel, Howard, & Haggard, 2011). These specific receptors would transmit explicit information regarding pain from the peripheral nerves on the skin and surface of the body, to the spinal cord, and then to the brain where the experience is processed.

Another biomedical theory of pain is the pattern response. This theory states that sensory, or nociceptive, information does not come from the activation of specific nociceptors (as thought by the specificity theory), but rather that it is initiated from a pattern of response in sensory systems (Gatchel, Howard, & Haggard, 2011). Therefore, in the pattern response theory, the perceptual response to the nociceptive input is determined by the intensity of the stimulus and by the processing of a pattern of responses.

The most widely held biomedical theory of pain is the gate control theory. The gate control theory states that pain arises from an interaction between 1) specific nerve function and input (i.e. the specificity theory), 2) pattern recognition of noxious pain stimuli (i.e. the pattern response theory), and 3) an alteration of these incoming signals by higher cortical functions of emotional amplification and cognitive interpretation (Johnson & Martinson, 2007; Gatchel, Howard, & Haggard, 2011). This means to say that any information coming in from specific nerves and patterns of recognition of pain stimuli is modified by the emotional response of the person experiencing pain and by the cognitive interpretation of the incoming information that is done by the person experiencing the pain. The theory emphasizes that pain is neither purely somatic nor psychological, but rather that complex neurophysiologic mechanisms found in both the spinal cord and the brain take part in modulating pain signals (Novy, 2004). Therefore, pain is ultimately a subjective and personal experience because pain is dictated by the emotional state and condition of the person as well as the interpretation that the person has of the incoming stimuli. The overall transmission and intensity of the signals produced that is experienced is controlled and modified by each person and each situation differently. This is why one can feel pain in one instance and then have the same thing happen to them in another situation and feel even more pain or less pain than was experienced before (McCaffrey, Frock, & Garguilo, 2003).

Gatchel's three stage model. Now that we have gone over the experience of pain and how pain is modified by each person's cognitive and emotional states, it is important for us to review how chronic pain arises. A common model for how chronic pain develops from a one-time painful experience or an acute stage of pain is Gatchel's three stage model (Gatchel, Howard, & Haggard, 2011). This model ultimately described the progression from acute pain to chronic pain and disability with (commonly) associated psychosocial distress.

The first stage of Gatchel's three stage model is the normal reaction to the perception of pain that happens during the acute pain phase (less than three months). At this time, it is normal for people to experience emotional reactions such as fear, anxiety, and worry that arise from this perception of pain.

However, if the pain lasts longer than two to four months, which is the timeframe in which the majority of musculoskeletal conditions normally improve or resolve, a person will experience increased psychological and behavioral distress and move into stage two of Gatchel's model. This often results in instances of learned helplessness, anger, and somatization (believing, in this case, that there is pain when there is no organic cause) due to the extended duration of pain. At this time pre-existing psychological characteristics, socioeconomic factors, and other environmental conditions will interact and act in unison to determine the form that these problems will take.

The third stage of Gatchel's model is entered when the stress of living with the chronic pain intensifies a patient's premorbid characteristics in a diathesis-stress process (Novy, 2004; Gatchel, Howard, & Haggard, 2011). This means that the pain disorder will have come to be and will continue to be a problem as a result of an interaction between a predispositional vulnerability and stress caused by life experiences (in this case pain, or injury). In other words, what should have been a pain experience that lasted less than three months will become a chronic pain experience due to stress and predispositional vulnerabilities. As the chronic pain persists it will also become the focus of the patient's attention. This will usually lead to a restructuring of the patient's life as the person habituates into a sick role, avoiding normal responsibilities and obligations, thus further reinforcing the malfunctioning state. Due to operant conditioning process and the complex interactions between physical, psychological and social processes, the

patient may become accustomed to avoidance of responsibility and may maintain a maladaptive approach to daily life tasks. In this stage of Gatchel's model one can often see physical deconditioning, which is a decrease in strength, flexibility, and endurance where the pain/injury occurred due to disuse and atrophy. Additionally, mental deconditioning may be observed, where emotional well-being is compromised due to the situation. These two deconditioning processes are synergistic in nature. Together, the ongoing pain, stress, psychological factors, psychosocial factors, and physiological factors may be combined with financial compensation issues (for example, due to missing work or to mounting hospital bills) and lead to significant obstacles for recovery. It is before and during this time that most patients will begin to seek out help for their chronic pain problems and may turn to medical and pharmaceutical treatments.

Opioid Treatment

Efficacy, safety, and tolerability. Opioid use in the treatment of chronic non-cancer pain has become increasingly controversial, however, it is still one of the most commonly prescribed medications for chronic non-cancer pain (White et al., 2011). Overall, opioid use is considered effective for the management of nociceptive pain and moderately effective for neuropathic pain. For example, in an eight-week, single-arm trial conducted in Korea, there was a statistically significant reduction in mean pain intensity score that represented an almost 25% decrease which corresponds to "much improved" or "very much improved" pain (Hwang et al., 2018). This reduction was even greater in the set within the intended-to-treat group, the patients who followed protocol. Their mean reduction in pain was 34%. Quality of life was also improved, by 38% for the overall intended-to-treat group, and by almost 22% for patients' perceived health status. In those who followed protocol, this improvement in quality of life jumped to 52.5%. Unfortunately, 120 adverse events were reported in 77 patients, meaning that 35% of those in the

study experienced at least one adverse event. However, the majority of these adverse events were considered mild (75.8%) and had resolved (54.7%), or were resolving (23.2%), at the end of the study period. The most common of these reactions were nausea, dizziness, constipation, and itching.

A meta-analysis examined three studies with a total of 908 patients investigated the efficacy of opioids (tramadol) versus a placebo (White et al., 2011). Researchers found that compared to those on placebo, patients who received the opioid reported statistically significant improved pain relief, improved function, and lower disability. The only adverse events reported in these studies were headaches and nausea.

Another meta-analysis analyzed 15 randomized placebo-controlled trials (four investigations with 120 patients studied intravenous opioid testing and 11 studies with 1025 patients studied oral opioids) (Kalso et al., 2004). The IV studies showed a 30-60% decrease in average pain relief, with a consistent opioid analgesic effect. Adverse effects happened in most patients, with 37% in one study vomiting and 90% in another study having to stop before the study was even finished. Mean pain relief was experienced for those who took oral medications, with a 30% decrease in pain for both neuropathic and nociceptive pain. However, trials reported large individual variation in terms of pain relief experienced. In the oral medication studies, 80% of patients experienced adverse effects in comparison to 56% in the placebo group. Overall, 80% of patients experienced at least one adverse effect and, in many cases, these adverse events prevented many patients from increasing their dose to the maximum allowed to improve pain relief experienced.

Opioid use in chronic pain management has garnered some attention in the past couple of years. The high adverse effect profile and conflicting results considering amount of pain relief

have caused opioids to be less favored in the pharmacological scene. Other pharmacological medications have been shown to be as effective, if not more effective, than opioids and with a less risky side effect profile. Additionally, opioid use in chronic pain management has been linked to substance abuse and addiction which is a distressing and longer-term side effect of the drug.

Substance abuse among opioid users and the opioid crisis. According to one of the most recent reports conducted by The Centers for Disease Control and Prevention in 2013, the total economic burden of prescription opioid misuse in the United States is around 78.5 billion dollars a year (Florence et al., 2016). This includes the cost of healthcare, loss of productivity, and addiction treatment. In fact, over one third of the amount was due to increased health care and substance abuse treatment costs. Additionally, almost two million people of those who were prescribed opioids were estimated to meet criteria for abuse and dependence and over 16,000 deaths were estimated to have occurred due to prescription opioid overdoses.

In one study conducted with data from 938,586 patients who were prescribed chronic opioid use due to chronic pain, researchers found that 75% of patients were unlikely to be taking their medications in a manner that was consistent with their prescribed regimen, 29% had nonprescribed medication present, 27% had a higher drug level than expected, and 11% had illicit drugs detected in their urine (patients may have fallen into more than one category) (Couto et al., 2009). This research suggests that a large percentage of those who are prescribed chronic opioids for their chronic pain may be taking their medications differently than what had been prescribed to them and that a smaller percentage of those may be engaging in further illicit drug use. It is possible that patient misunderstanding may have led to some of the results reported, but for three fourths of a sample of over 900,000 participants to be taking their opioids in a non-

prescribed manner is alarming. Additionally, researchers pointed out that some patients may refuse or simply not complete ordered drug screens or may defer their drug screening if they had illicit drugs or inappropriate amounts of opioids in their system. At the very least, this data suggests the need for more pharmacotherapeutic coordination across various providers, a higher emphasis on correct documentation, and more checks with pharmacies on whether patients have other or similar prescriptions already prescribed for them. This type of practice may cut down on “drug shopping”, where a patient gets similar prescriptions from different doctors but uses the same pharmacy.

Conversely, a review of prevalence of substance abuse among chronic pain patients that were prescribed opiates found that opioid dosage was not associated with misuse or addiction, and neither was pain intensity (Martel, Shir, & Ware, 2018). Instead, researchers found that determinants of substance abuse lied with the user specifically, with higher rates of substance abuse found among males and younger patients. Predictors of addiction and misuse were found to be anxiety, personality disorders, negative affect, and depression. This data suggests that while opioid dosage itself may not be correlated with higher rates of substance abuse, clinicians should work to identify patients who may need closer monitoring over the course of opioid drug therapy, may need more checks for patients that show signs of addiction or misuse, and that clinicians should make sure to screen patients before administering drug therapy. Similar to the study mentioned before, researchers in this review mentioned the lack of communication between doctors, pharmacies, and patients, as well as unsystematic documentation, as a limitation of results found. They also noted, as mentioned before, that patients may go to several doctors for prescriptions which could also lead to unreliable data.

The above data suggests that there is a high prevalence of substance abuse among chronic pain patients who are prescribed opiates. Though it seems that opioid dosage and pain intensity are not correlated with substance abuse regarding opiates, the number of patients found inappropriately taking their opioid medication is cause for alarm. There needs to be more emphasis within the healthcare system to screen patients who have predictive factors of substance abuse with opioid therapy before administering opiates, and there is a need for more follow-up after opioids have been prescribed. Additionally, providers within the healthcare system have a duty to their patients to have better communication between each other in order to stop dangerous actions such as “drug shopping” from taking place.

Non-opioid Treatments

Due to the controversial nature of opioid use for chronic pain treatment because of its risky side effect profile and correlation with substance abuse, alternative medications have been sought out and brought to the forefront of chronic pain management. There are many alternative drugs that are used when combatting chronic pain and more research is being done on alternatives to opioids as doctors shy away from using them in treatments.

Antidepressants. A review of national and international guidelines for the treatment of chronic pain (particularly lower back pain) reveals that recommendations for antidepressants vary substantially, with only half of the guidelines published recommending their use, and none indicating whether they should be prescribed in high or low doses (Urquhart et al., 2018). Additionally, while antidepressant efficacy is well documented for neuropathic pain, the evidence is less clear in the case of chronic musculoskeletal pain (Schliessbach et al., 2018; Laguerre, 2013).

A systematic review that analyzed 174 randomized, double-blind, placebo-controlled studies in the pharmacological treatment of chronic neuropathic pain conditions showed that tricyclic antidepressants (TCAs) were shown to relieve various types of neuropathic pain conditions (Finnerup, Sindrup, & Jensen, 2010). TCAs were also reasonably well tolerated but high doses were cautioned against and were considered a matter of concern. Some serotonin noradrenaline reuptake inhibitors (SNRIs) were shown to relieve neuropathic pain, however selective serotonin reuptake inhibitors (SSRIs) were shown to have a weak analgesic effect. Further research has shown that SSRIs have less efficacy when it comes to degree of pain relief when compared to TCAs, but SSRIs have been found to have fewer side effects than TCAs. Additionally, one SNRI (duloxetine) was one of the first antidepressants to have been approved by the FDA with a specific indication for pain, particularly neuropathic pain (Laguerre, 2013).

With similar results, another meta-analysis that compared over 229 randomized, double-blind studies of pharmacotherapy for neuropathic pain found SNRI quality of evidence to be high, the effect size to be moderate, and the tolerability/safety to be moderate (Finnerup et al., 2015). Overall, researchers in this meta-analysis strongly recommended SNRIs for the treatment of neuropathic pain. Likewise, the quality of evidence for general antidepressants was high, the effect size moderate, and the tolerability/safety low-moderate. Their recommendation for the use of general antidepressants in the treatment of neuropathic pain was also strong. Together, SNRIs were strongly recommended as first-line use medications, with caution recommended for several antidepressants at high doses.

However, another meta-analysis that reviewed 6 trials compared antidepressants with placebo in 376 patients and found very different results when they addressed musculoskeletal chronic pain treatment instead of neuropathic pain treatment (White et al., 2011). In this meta-

analysis, antidepressants were not shown to be more effective than placebo with respect to pain, functional status, or even depression. There was no data reported on the studies that spoke to the safety of antidepressant use in chronic pain management or treatment.

Similarly, a review that analyzed 3 studies with 606 participants compared a TCA (mirtazapine, 15-45 mg/day) with placebo or other active drugs in the treatment of fibromyalgia for seven to thirteen weeks (Welsch et al., 2018). This review found clinically-relevant benefits for TCA use compared to placebo for participant-reported pain relief of 30% or greater, reduction of mean pain intensity, and sleep problems. However, no benefit was found for health-related quality of life, fatigue, negative mood, pain relief of 50% or greater, or withdrawals due to lack of efficacy. Researchers interpreted the results conservatively, concluding that 15-45 mg/day of mirtazapine would be unlikely to substantially reduce pain, and that instead may help a small number of people experience some pain improvement (moderate pain relief, better sleep) without too many adverse side effects. Future studies would be advised to look into larger dosages of TCAs in the treatment of chronic pain to assess their efficacy in musculoskeletal chronic pain management.

Conversely, some stand-alone studies showed more promise for the use of antidepressants in the treatment of chronic musculoskeletal pain. One double-blind clinical trial in Australia New Zealand randomized 146 participants with chronic low-back pain into two groups, one received a low-dose TCA (amitriptyline, 25 mg/day) and the other one received an active comparator (benztropine mesylate, 1 mg/day) once a day for 6 months (Urquhart et al., 2018). One hundred eighteen of the participants completed the 6-month follow-up. The only statistically significant difference found was that the TCA group had a larger improvement in disability at three months (but not at 6 months). There was no difference in pain reduction at

three or six months, no difference in work outcomes at three or six months, and no difference in the number of participants that withdrew due to adverse events. However, due to the statistically significant improvement in disability at three months and the minimal adverse effects experienced by participants, researchers concluded that the study provided evidence to suggest that TCA treatment may have a therapeutic effect for musculoskeletal chronic pain, particularly chronic low-back pain.

A similar and interesting finding was found in another study that looked at 50 participants in Switzerland with chronic low back pain (Schliessbach et al., 2018). The study had a randomized, double-blind, placebo-controlled design in which a TCA (imipramine) was compared with a placebo. Unique to this study was the multimodal quantitative testing that was done, as well as genotyping for a gene that had to do with drug metabolism. Imipramine was at no point significantly different from placebo in pain relief experienced in the sitting or supine position. Similarly, no effect could be observed in the quantitative sensory tests except for 1.05 times higher pressure pain tolerance threshold for the treatment group after 120 minutes. However, interestingly enough, the outcomes changed when the rate of metabolization of the drug was taken into account. Intermediate metabolizers of the drug showed a 1.15-1.20 higher electrical single pain threshold at 60 and 120 minutes after treatment (compared to placebo), and a similar but weaker trend was found for the electrical repeated pain threshold. Additionally, intermediate metabolizers had a tendency towards higher pressure pain detection thresholds and pressure pain tolerance thresholds after 60-120 minutes. It should be noted that extensive metabolizers showed no such effects. On the whole, the study failed to demonstrate immediate analgesic effects of a single dose TCA on chronic musculoskeletal pain but found anti-nociceptive effects in intermediate metabolizers of the drug. Researchers argued that it may be

possible that a single oral dose of the TCA was not sufficient to find effects or that a two-hour time frame may have been inefficient, but also recognized the possibility that the drug was not effective in musculoskeletal pain treatment at all.

Largely, antidepressant efficacy has mixed results dependent on the type of chronic pain. In the case of neuropathic chronic pain there is strong support for the use of antidepressants, though caution should be taken for high doses of antidepressants. Furthermore, one SNRI has even been approved by the FDA specifically for neuropathic pain, adding to its credibility as a good contender for first-line defense for neuropathic chronic pain. However, mixed results are shown for the efficacy of antidepressants when it comes to musculoskeletal pain. Some studies show low to no efficacy, and one study pointed out that a low dosage may not be enough to show analgesic effects in musculoskeletal pain. Though I would recommend against increasing the dosage drastically in future studies of antidepressant use on musculoskeletal chronic pain, as high doses of antidepressants have been cautioned against due to the higher risk profile associated with them. Additionally, there was evidence by one study that different metabolizers of antidepressants, particularly TCAs, may find different analgesic effects that are more beneficial. Still, more research has to be done in that area of study before any conclusive recommendations can be made.

Nerve pain anticonvulsants. There are mixed data to support the use of anticonvulsants when it comes to treating chronic pain, though, much like antidepressants, they tend to fare best when used in the treatment of neuropathic pain (Finnerup, Sindrup, & Jensen, 2010). A systematic review of several medications for the treatment of chronic neuropathic pain found anticonvulsant quality of evidence to be high, the effect size to be moderate, and the tolerability and safety of the drug to be moderate-high across a subset of 229 overall studies. The

recommendation rating for anticonvulsants in the treatment of neuropathic pain was given as strong, and anticonvulsants were among those strongly recommended for first-line use.

Anticonvulsants were particularly recognized for their lower adverse effect profile (Finnerup et al., 2015). Another meta-analysis that surveyed over 170 studies found that anticonvulsants showcased a clinical and relevant effect across several trials for peripheral and central neuropathic pain conditions. The researchers concluded that anticonvulsant efficacy in the treatment of neuropathic chronic pain has been well-documented (Finnerup, Sindrup, & Jensen, 2010). In many cases, anticonvulsants can be successful in treating pain when opioids show little efficacy for a patient, such as in cases of neuropathic pain (Laguerre, 2013).

A 12-week randomized, double-blind, placebo-controlled, parallel-group study found similar results when it evaluated the efficacy and safety of an anticonvulsant (pregabalin) in the treatment of chronic neuropathic pain (Freynhagen et al., 2005). This study was unique in that it evaluated two regimes of anticonvulsant treatment: flexible schedule of 150, 300, 450, and 600 mg/day with weekly dose escalation based off of patient individual response and tolerability, and a fixed schedule of 300 mg/day for one week followed by 600 mg/day for the following 11 weeks, both compared to placebo. Of the 338 participants in the study, 59% on flexible-dose, 66.4% on fixed-dose, and only 37.1% on placebo had a greater than 30% pain score reduction. Similarly, compared to the placebo, both treatment regimens resulted in statistically significant improvements in pain symptoms of at least a 50% pain score reduction (48.2% on flexible-dose, 52.3% on fixed-dose, and 24.2% on placebo). Altogether, the flexible-dose treatment group achieved statistically significant improvement as early as week two, and the fixed-dose group as early as week one, when compared to placebo, and both were maintained throughout week 12. Adverse events were found more commonly in fixed-dose treatment participants, followed by

flexible-dose and then placebo. Sixty-six percent of participants experienced one or more adverse effect (74.2% on fixed-dose, 68.6% on flexible-dose, and 27.7% on placebo), most of which were treatment related but mild or moderate in intensity and generally transient. This suggests that adverse effects may be managed better by a more individualized dosing schedule. On the whole, the anticonvulsant treatment was determined to be safe, effective, and generally well tolerated.

Two studies were found that analyzed the effects of anticonvulsant medication on musculoskeletal pain. Atkinson and colleagues (2016) recruited a total of 108 veterans with chronic low back pain with and without radiating pain to legs were randomized into a treatment group (forced titration of gabapentin of up to 3600 mg/day) and an inert placebo group, of which 72 total participants finished all 12 weeks of the study. Researchers found no support for analgesia with gabapentin at the end of 12 weeks for both study groups of participants and for those with and without pain radiating to legs, and no difference between the groups for disability. There were also several people who withdrew from the study (19 from treatment and 17 from placebo) due to lack of efficacy or adverse events, which was surprising due to gabapentin often being considered as having a benign side effect profile. The researchers of the study had no explanation for the high withdrawal rate but believed that there was a possibility that a small sample size and low average pain intensity (often rated by participants as mild-to-moderate) may have contributed to finding no analgesic effect for the anticonvulsant due to lack of power or a basement/floor effect. Conversely, Schliessbach and colleagues (2017) conducted a double-blind cross-over study, on 49 patients with chronic low-back pain in Switzerland and found more positive results. Patients in this study either received a single dose of an anticonvulsant (20 mg of clobazam) or a single dose of an active placebo (one mg of tolterodine), and then pain was

assessed in the supine and sitting positions as well as for quantitative sensory tests (heat, pressure, cold, electrical stimulation, etc.). Researchers found that pain intensity in the supine position was significantly reduced by the anticonvulsant in comparison to the active placebo but found no significant difference between the groups in the sitting position. Additionally, no significant effects were found when the quantitative sensory tests were performed. Overall, the researchers concluded that a single oral dose of anticonvulsant medication was more effective than an active placebo at reducing chronic low-back pain. They also mentioned that muscle relaxation or sedation may have been the way by which an analgesic effect was found in the anticonvulsant treatment group. The possibility of an anti-hyperalgesic effect of the anticonvulsant was also reported.

The combined research shows evidence for the use of anticonvulsants in the use of neuropathic chronic pain with high efficacy, generally safe ratings and well-tolerated use. However, anticonvulsants have yet to be further researched in their analgesic use in musculoskeletal chronic pain. Mixed efficacy results were found in their use for musculoskeletal chronic pain, with some studies citing possible analgesic effects and others finding no significant effect. It is possible that higher or more doses of anticonvulsants could reduce chronic musculoskeletal pain, but more research will need to be done in order to draw well-supported conclusions on the matter.

Nonsteroidal anti-inflammatory drugs (NSAIDs). NSAIDs are considered an effective treatment of chronic musculoskeletal pain, known for their faster onset of analgesia and rapid pain relief. NSAIDs have peripheral and central anti-inflammatory activity and affect the synthesis activity of other neuroactive substances which may play a role in processing nociceptive input. NSAIDs also have a better safety profile, making them a more attractive

resource when combating chronic pain (Kaye et al., 2018). NSAIDs have been shown to be most useful for treating chronic pain that arises from trauma, arthritis, and surgery, and are notable for not producing psychological or physiological dependence. A drawback to them however is that there is a ceiling effect experienced in the dose-response curve of NSAIDs, meaning that after a therapeutic ceiling has been reached, increasing the dose further will increase side effects but not analgesia. Additionally, though NSAIDs are considered generally safe, they can have common and potentially serious side effects if not prescribed well (Laguerre, 2013).

One meta-analysis of four trials compared NSAIDs with placebos in 1020 patients with chronic low-back pain (with or without radiating pain) and found promising results (White et al., 2011). The combined results of all four studies showed statistically significant decreases in pain intensity for the NSAID treatment over the placebo group. Side effects were reported in 1034 of participants, and there were significantly more adverse effects reported for the NSAID group. However, specific side effects were not listed in the meta-analysis, so conclusions about safety of the drug cannot be accurately drawn. All in all, NSAIDs were concluded by researchers to be good candidates for treatment of chronic musculoskeletal pain, particularly low-back pain, with strong recommendations. They were shown to be favorably effective (though with a possibly significant side effect profile), and in the scheme of a larger meta-analysis were found to be similar in effectiveness to opioids.

With similar positive results found, a study compared the effect of opioid medication versus non-opioid medication in the form of NSAIDs (Krebs et al., 2018). 234 patients from Veterans Affairs clinics took part in this pragmatic, 12-month, randomized trial in which patients followed either an opioid or non-opioid medication therapy using a treat-to-target strategy. Medications were changed, added, or adjusted depending on individual treatment response and

was done so within the assigned treatment group. At the end of the 12 months the two groups did not differ significantly on pain-related function (with most patients from both groups improving on pain-related function), but pain intensity was significantly better in the nonopioid group.

Adverse medication-related symptoms were reported more often in the opioid group over the testing period, but this did not reach significance. The findings of this study suggest, similarly to the meta-analysis analyzed before, that treatment with opioids was not superior to treatment with NSAIDs in terms of improving pain-related function over a year long period. Overall, opioids did not demonstrate an advantage that could outweigh their greater risk of harm, and therefore researchers recommended that NSAIDs be considered in the use of chronic pain over opioid use.

The collective data suggests that NSAIDs are a good pharmacological treatment for chronic pain. Additionally, the data seems to suggest that NSAIDs may be better prescribed for chronic pain than opioids due to their lower risk profile and similar efficacy for pain management. This makes NSAIDs good contenders for first line defense in chronic pain management, though they have a possibly significant side effect profile.

Combinations of Pharmacological Treatments

Sometimes when drugs are not sufficient by themselves a care provider may prescribe one or more in combination with the first drug. This practice is done in order to maximize the effects of the drugs used and is meant to be a complementary practice. Prescribing more than one drug to attempt to achieve pain relief is common due to the limited efficacy of current available treatments (Finnerup, Sindrup, & Jensen, 2010).

Anticonvulsants and opioids. One study found mentions the use of gabapentin, a common anticonvulsant, with combinations of opioids (Gilron et al., 2005). In the study, gabapentin was combined with morphine and it was found that the combination of drugs

provided better pain relief than each given on their own, but the gains in pain relief were modest at best. Additionally, the researchers found that the effects were not significant, but mentioned that the absence of statistically significant results may have been due to the study's insufficient statistical power. Another study analyzed gabapentin and oxycodone together, finding significant pain relief in that specific combination with the added bonus that adverse effects were not exacerbated by the combination of the two drugs (Hanna, O'Brien, and Wilson, 2008). The study in question was done specifically on neuropathic pain, which may hinder the generalizability of the results to musculoskeletal pain. The final study that analyzed the combination of anticonvulsants and opioids found that gabapentin and nortriptyline combined at maximum doses of each also produced greater pain relief than each drug could do on their own (Gilron et al., 2009). The combination also produced less frequent and less dangerous adverse events than each drug on its own. These studies analyzed are hopeful when looking at administering more than one drug for chronic pain relief.

Generally, there seems to be support for the idea that combining drug therapies can reduce the dosages of specific medications and can contribute to higher analgesic effects. More research should be done on specific pharmacological therapies that complement each other best without increasing adverse side effect profiles, especially since there was a lack of general research on combinations of drugs and their effects (as only anticonvulsant and opioid combinations were found for this review). It should be noted, that like any medication regimen, caution should be taken when combining drug therapies and when prescribing combination drug therapies to patients.

Limitations and Considerations

While many of the drug options and therapies outlined above have shown pain relief capabilities in research, it is important to note that most of the drugs mentioned provided some pain relief but often did not provide total pain relief or even moderate to high pain relief (Freynhagen et al., 2005; Finnerup, Sindrup, & Jensen, 2010; White et al., 2011). Additionally, many of the drugs discussed came with serious side effect profiles and adverse events that caused participants to reduce dosage during the studies or even withdraw completely. It is therefore important to remember that medication rarely eliminates pain, and therefore “painkillers” is a misnomer. The risks that patients may take in order to achieve a “pain-free” state may include medication overuse, risky doses, side effects, and addiction. Overuse of medication can worsen pain, promote increasing medical complexity, and can lead to polypharmacy (when multiple medications are co-prescribed, usually to treat side effects from previously prescribed medications) (Darnall, 2019).

Furthermore, specifically within the case of prescribed opioids for chronic pain, there is a high prevalence of substance abuse among patients, and a lack of systematic documentation and communication between doctors, pharmacies, and other healthcare providers (Couto et al., 2009; Martel, Shir, & Ware, 2018). This lack of documentation and communication has led to a phenomenon known as “drug shopping”, in which patients acquire several similar prescriptions from different doctors. “Drug shopping” is a dangerous outcome due to neglect of care in the healthcare system and is usually caught when a patient attempts to fill these prescriptions all at the same pharmacy. Pharmacists should therefore be considered a first line of defense against “drug shopping” and should be considered an important voice within the healthcare system to stop and prevent the abuse of opioid medications. There also needs to be more follow-up after drug regimens have been prescribed, and there needs to be more communication within the

healthcare system in general. Providers have a duty to their patients to also screen them before administering any drug therapy to check for predictive factors of substance abuse.

Another limitation within the realm of pharmacological therapies is the publication bias towards meaningful results (Finnerup et al., 2015; Krebs et al., 2018). Many pharmacological studies may not have been reported on because of high adverse effects, high placebo effects, or not finding significant results. These studies may have been rejected from publications in journals, even though non-significant results are still important to report because they add to the literature and understanding of pharmacological therapies within the realm of chronic pain management.

Chapter 3: Psychological Treatment for Chronic Pain

Many of the patients who seek out help for their chronic pain through pharmacological methods are left with high and risky side effect profiles, as well as incomplete and in some cases inadequate analgesic effects. Misinformed patients will often believe that pharmacological treatment will completely “cure” their chronic pain, and so patients may expect to approach the end of their pharmacological treatment in a pain-free (or virtually pain-free) state (Veehof et al., 2016). However, it is known now that most patients who seek out pharmacological treatment do not achieve pain-free status, and many may not even feel much of an analgesic effect from pharmacological treatment (Finnerup et al., 2010; Darnall, 2019). Additionally, there may be serious drawbacks to treatments that end up in patients being unable to take the maximum dose needed to achieve analgesic effects or may even result in patients discontinuing treatment due to the adverse effects experienced (Kalso et al., 2004; Atkinson et al., 2016). Psychological research has helped to explain why many patients who seek out pharmacological treatment do not achieve the pain free life they hope for. Psychological research may be a means to help fill in

that gap of further pain relief and management. Models such as the fear-avoidance model and the psychological flexibility model, along with a biopsychosocial perspective have helped to shed light on the matter.

Models for the Psychological Approach

Fear-avoidance model. The fear avoidance-model focuses on how pain is interpreted. One way in which pain is interpreted and does not lead to chronic pain is when acute pain is perceived as non-threatening (i.e. patient interprets that they can function despite discomfort), leading patients to maintain their engagement in daily activities through which functional recovery is then promoted. The other way in which pain is interpreted leads to chronic pain and is the basis of the fear-avoidance model (Leeuw et al., 2007; Tang, 2018). This happens when pain is catastrophically misinterpreted, and these dysfunctional interpretations then give rise to pain-related fear, leading to associated safety seeking behaviors such as avoidance/escape and hypervigilance which then worsen the problem in the case of chronic pain (Figure 1, Appendix A). This pain-related fear has been found to be associated with diminished participation in activities of daily life, greater perceived disability, more frequent sick leave, and diminished performance on a lifting task (Novy, 2004; Leeuw et al., 2007; Crombez et al., 2012). Additionally, some long-term consequences such as disability and disuse that tend to occur with chronic pain may lower the threshold at which later pain will be experienced, leading the patient to experience pain at lower thresholds and therefore more easily (Crombez et al., 2012).

There are three main components of fear which are important to note in this model. The components are 1) the interpretation of the stimulus as threatening to bodily integrity (i.e. causing the body to be weakened or frail in some way so as to require extra care), 2) an increased sympathetic arousal (and therefore a heightened experience of the pain), and 3) defensive

behavior. Defensive behaviors may be adaptive in the short term and can reduce fear levels but may actually strengthen fear in the long run and become maladaptive in the case of chronic pain (Leeuw et al., 2007; Crombez et al., 2012). This is because chronic pain is essentially persistent and always lingering, leading to constant fear.

Anxiety is also important in this model. Anxiety is a future-oriented affective state that is associated with preventative behaviors such as avoidance. Anxiety may also lead to hypervigilance, which is when an individual engages in environmental scanning in order to find potential sources of threats, then selectively attends to threat-related rather than neutral stimuli and essentially narrows the attention in the presence of such stimuli. This hypervigilance, like other defensive behaviors, may reduce anxiety in the short term but are counterproductive in the long term (Leeuw et al., 2007; Crombez et al., 2012). In this case, hypervigilance leads to increased sensitivity to pain.

This pain-related fear and anxiety emerges when the stimuli related to pain is perceived as a main threat. In the case of enduring pain, when the pain may no longer be explained by an injury, the fear can become dysfunctional because it is no longer serving the purpose of drawing attention to injury in order to enhance care and facilitate the healing process. When the pain is enduring, psychophysiologically one may experience heightened muscle reactivity. Behaviorally one may engage in escape and avoidance behavior. Cognitively one may engage in catastrophizing thoughts. All of these things together combine to heighten the experience of pain. Pain-related fear can sometimes be more disabling than the pain itself, especially when the patient engages in pain catastrophizing (when an anxious patient dwells on the most extreme negative consequences imaginable). This pain catastrophizing has been consistently associated with pain disability in chronic pain patients and has been shown to lead to subsequent activity

intolerance and intensified pain. The reduction of pain catastrophizing has been linked to significant reductions in pain disability for chronic pain patients (Buhrman et al., 2015).

Overall this pain-related fear may stop people from returning to normal daily life activities, may lead to excessive disuse of their body or injured/painful area, and can lead to psychosocial stress through isolation and inability or low motivation to return to activities. The fear may also cause patients to think they are less capable than they really are in terms, for example, of range of movement (Novy, 2004). It is possible that this pain-related fear is the mechanism behind the maintenance of chronic pain and pain disability. The fear-avoidance component may prevent patients from discovering that feared activities are harmless, and that not performing them actually promotes disability and disuse. Additionally, hypervigilance and fear of re-injury may lead to patients who ruminate on their pain and exacerbate their condition. This could lead to intensified pain and leave less attention to other tasks or activities, furthering isolation. It is also important to note that in this model it is recognized that certain vulnerabilities such as neuroticism, anxiety, and depression may make a patient more vulnerable to the development of chronic pain (Leeuw et al., 2007).

Biopsychosocial perspective. The biopsychosocial approach acknowledges the multiple components that interact in a dynamic manner unique to each individual. These components are psychological, behavioral and sociological. This model believes that pain is a unique and individual experience that is affected by these factors, but that no single factor is deemed exclusively responsible for the complexities that are often encountered in chronic pain assessment and treatment (Novy, 2004; Gatchel, Howard, & Haggard, 2011).

An example of this model is stress and chronic pain. Chronic pain is often termed an “inescapable stressor” due to the disability it causes, the pain, and the psychosocial stress

associated with it. This stress from chronic pain exacerbates the pain, which then causes an increased level of pain, which in turn becomes a stressor. This endless loop then causes interference in daily life, racks up hospital bills and causes people to miss time from work. Unfortunately, this interaction between behavior, psychological, and social factors is one that is all too common for those that experience chronic pain.

The biopsychosocial approach also identifies three main comorbidities often found with chronic pain. These comorbid psychopathologies may perpetuate the dysfunction and disability that is associated with pain. These are mood disorders, anxiety disorders and substance abuse disorders. Mood disorders, such as depression, have been linked to less successful treatment outcomes and amplifications of medical symptoms. Anxiety disorders are associated with lower pain thresholds and pain tolerance. There is an unclear causality in whether anxiety is a predisposition for chronic pain or whether chronic pain causes anxiety in people. It is likely that the relationship goes both ways. The last, substance use disorders, are associated with chronic pain because there is an increased risk for new substance abuse disorders following the onset of chronic pain after 5 years (Gatchel, Howard, & Haggard, 2011).

Psychological flexibility model. The psychological flexibility model is based off of the capacity to persist or change behavior in a way that 1) includes conscious and open connection with one's thoughts and feelings, 2) appreciates what a situation gives to you and 3) is guided by a person's own goals and values (McCracken & Morley, 2014). Often the behavior that results from the psychological flexibility model is described as behavior that is open, aware and active.

This model works off of the idea that there are two important influences that interact with each other and create and coordinate behavior. One such influence is the direct experience that one has with the world, included experiences such as the sensory experience to see, hear, smell,

taste, and feel. The other influence is based off of the verbal, language-based and/or cognitive processes experience. This includes things such as rules, instructions, stories, judgements, expectations and appraisals. An example of how these influences can become maladaptive is when the verbally-based influences take over. For example, humans will naturally create verbal constructions of the world – such as, *I cannot do anything today because the pain is so bad* – and sometimes will end up engaging in behavior that is then insulated from the real world by these constructions, failing to see that the verbal constructions of the world they have created are not in fact the world. This kind of process is named cognitive fusion, and it is one of the key processes behind the psychological flexibility model.

Cognitive fusion is an automatic process, meaning that it typically happens outside of one's awareness, where the literal content of a person's thoughts is dominated over other sources of behavioral influence, and therefore the situation or experience the person is having is dominated and experienced only through what the thought content says (rather than taking into account other thought contents or sensory experiences) (McCracken & Morley, 2014). In practice this can lead to restrictions of a person's behavior, such as a restriction in someone reaching for their goals (Novy, 2004; Tang, 2018). Cognitive defusion, used to remedy cognitive fusion, aims to reduce the dominance and impact of cognitive content (such as analyzing, judging, and thinking) without changing the cognitive content itself. The method works by reducing the literal function of thought content so that it is not taken as the only influence on behavior, therefore reducing restrictions made on behavior by the sole thought content and enhancing other functions (allowing other influences to shape the maladaptive thought into less of an overwhelming, believed, and followed concept into the experience of seeing the thought as simply a thought). For example, a patient who believes they cannot function due to their pain level may avoid going

for a walk. However, if they had attempted to go for a walk despite their pain and realized that they are capable to engage in light activities, this new influence upon their thought structure would have taught the patient that engaging in light activity is okay and that they are not in too much pain to function in light daily activities. This is an example of the way the psychological flexibility model can remedy a maladaptive belief, particularly one that is prominent in chronic pain.

Overview and general remarks. Overall, the reason that these theories and models have proven to be important in the field of psychological research having to do with chronic pain is that they have helped shape and form the psychological therapies that are used for chronic pain management. It has been shown that the above-mentioned theories and models have achieved very good treatment outcomes in patients with chronic pain without necessarily relying on pain reduction or without a substantial correlation found between change in pain and improvement in other domains (Veehof et al., 2011; Reiner, Tibi, & Lipsitz, 2013; McCracken & Morley, 2014). This signifies there must be other aspects to pain rather than just the sensory experience that can change the outcome of peoples' lives who live with chronic pain, whether this is through helping patients accept pain as a part of their experience or by helping them move through their daily life and continue with activities they enjoy despite the pain they may feel. The most used therapies for chronic pain management discussed below will attempt to shed light on the ways that psychological treatment can be used to treat chronic pain.

Cognitive-Behavioral Therapy (CBT) Based Approaches

Cognitive-behavioral therapy (CBT). There are two main principles that used in chronic pain treatment that stem from CBT. One essential idea is that feelings of pain and aspects of emotional, physical and social functioning that are impacted by pain are related but

separable (Tang, 2018). This means that problems having to do with functioning that are related to pain can be addressed even when the pain itself is not targeted directly or when there is no change in pain (Novy, 2004). The second essential idea is that pain is influenced by psychological factors, which essentially can be seen through the biopsychosocial perspective (Novy, 2004; McCracken & Vowles, 2014; Tang, 2018). These two essential ideas help to form what is one of the most researched and fundamental family of psychological treatments for chronic pain patients. Additionally, it has been found that CBT can be beneficial in decreasing pain-related fear. CBT has been found to be effective in reducing disability associated with decreases in pain catastrophizing and pain-related fear, helping to dismantle a possible mechanism of chronic pain maintenance found through the fear-avoidance model (Leeuw et al., 2007). In one study, CBT patients, compared to an educational control group, showed significantly greater short- and long- term changes in pain-related beliefs such as decreases in the belief that they were disabled, belief that pain signaled harm, and catastrophizing (Turner, Mancl, & Aaron, 2006). The CBT patients also showed increases in perceived ability to control pain.

Testaments to CBTs efficacy for chronic pain treatment are numerous. One meta-analysis and systematic review of 25 randomized-controlled trials with a total of 1,672 chronic pain patients found that patients who received CBT treatment improved on average by half a standard deviation in pain experience relative to those assigned to waiting list control conditions (Morley, Eccleston, & Williams, 1999). The researcher found CBT to be more efficacious than waiting list control conditions for all measurement domains - pain experience, mood/affect, cognitive-coping and appraisal, and social role performance - except for pain behavior. Particular components of CBT such as behavior therapy, biofeedback, and relaxation treatments were found to be

particularly effective in changing pain experience (i.e. reducing pain intensity and improving social role functioning) and in reducing negative appraisal and coping such as catastrophizing.

In line with the meta-analysis' findings, a systematic review of chronic pain and CBT of over 4,788 patients in over 51 studies found sufficiently large evidence to show that CBT contributed small to moderate beneficial effect sizes in the reduction of pain, disability, and psychological distress that was on par to that of established drug and physical treatment for chronic pain (Tang, 2018). However, the researcher posed two important questions regarding CBT usage in the healthcare system: "*who with what training should be delivering the treatment in what dosage, format, and sequence?*" and, "*where should we situate [CBT] within the existing clinical care pathway to achieve optimal long-term cost-effectiveness?*". Two important questions that remain unanswered by many of the studies.

One particularly hopeful randomized controlled study for short- and long- term CBT efficacy was conducted on patients with chronic pain due to temporomandibular disorder (a disorder that involves the muscles around the face and associated structures and can lead to restricted jaw function) (Turner, Mancl, & Aaron, 2006). The CBT group had significantly better outcomes in all outcome measures, including decreased pain-related activity interference, characteristic pain intensity, depression, and increased jaw function. These significant differences remained stable at the 12-month follow-up. Apart from being significant, the better outcomes were impressively larger. For example, the odds of reporting no activity interference at the 12-month follow-up was four times greater in the CBT group, and at the end of the 12-month follow-up the proportion of patients with clinically significant levels of depressive symptoms in the CBT group was less than half of that found at baseline. The results remained significant even when accounting for baseline levels.

CBT has also been shown to be efficacious when administered online (Buhrman et al., 2015). A randomized controlled study on individualized and guided internet-delivered CBT for patients with comorbid depression and anxiety found significant and clinically relevant decreases in depressive symptoms (moderate effect size) and pain disability (small effect size) for those in the treatment group compared to the education control. There was also a small, significant, and clinically relevant increase in activity engagement for the treatment group. These results were maintained through a one-year follow-up.

Overall, CBT has been shown to produce favorable effects of small to large effect sizes for multiple musculoskeletal chronic pain treatments. These favorable effects have been found in the domains of decreased pain disability, depressive symptoms, and pain experience. Due to the lack of data, there is no specific conclusion that can be drawn about CBT's effectiveness with neurological chronic pain management.

Challenges that arise with CBT in chronic pain treatment. One main problem with CBT treatments used in chronic pain patients is that studies have yet to identify specific processes to CBT that are both sufficient and necessary for the benefits that are observed in treatment and have yet to identify the methods that impact these processes (McCracken & Vowles, 2014). This problem leads to less-than-optimal treatment impact in the long run because since researchers cannot pinpoint specific parts of CBT that lead to benefits, then methods and components of CBT cannot be optimized for chronic pain treatment and therefore no leaps and bounds can be made in the realm of CBT treatment for chronic pain, leaving patients, researchers, and care providers in a rut. Another problem found with CBT treatments used for chronic pain is the increasingly supported belief that a patient does *not* need to change their thoughts or beliefs in order to change one's behavior, recover from psychological problems, or experience pain relief.

This can be seen in evidence provided through pain relief found in mindfulness techniques, which do not focus on changing thoughts or beliefs but rather are grounded in calling attention elsewhere and cultivating an aspect of awareness and openness to experience (Kabat-Zinn, 1984; McCracken, Gauntlett-Gilbert, & Vowles, 2007; Reiner, Tibi, & Lipsitz, 2013; Hilton et al., 2017). Therefore, in this light CBT, which is grounded in confronting negative automatic thoughts and changing the content of those thoughts, is seen as more obsolete. This evidence contradicts and fails to support the traditional CBT perspective which relies on a mechanism of change.

However, not all hope is lost. There are emerging therapies within the umbrella of CBT that have shown promise. Among those emerging therapies are acceptance-based therapies and mindfulness-based therapies.

Acceptance and commitment therapy (ACT). Acceptance and commitment therapy, also known as ACT, is a treatment approach developed from, and within the family of, CBT. ACT emphasizes cognitive processes and emotional experiences through a combination of “acceptance and mindfulness methods along with activation and behavior change methods” (McCracken & Vowles, 2014). Unlike CBT, however, ACT does not have an explicit emphasis on reducing pain behaviors and increasing healthy behaviors (Dahl & Lundgren, 2006). This down-to-earth approach employed in ACT is centered around reaching goals, and therefore the skills are specifically used functionally and contextually rather than all the time.

Overall, ACT theory acknowledges that people are influenced by cognitive processing and by direct sensory contact with the world. The problems that arise from this interaction are when cognitive-based influences dominate a person’s behavior without the person being aware of it, and possibly end up leading to behavior that is ineffective in terms of achieving one’s goals

(Dahl & Lundgren, 2006). Therefore, ACT is context-specific in that when a patient sees that their actions are not leading to desired goals, then the patient is encouraged to redirect their behavior and be motivated to change in order to re-align with achieving their goals.

ACT and chronic pain. In the context of chronic pain, ACT theory relies on two aspects of pain acceptance to help patients achieve their goals: 1) willingness to experience pain and 2) willingness to engage in valued activities despite pain experienced. A systematic review of ACT and chronic pain mentioned how in laboratory studies, ACT produced greater tolerance of pain and discomfort when compared to distraction and cognitive restructuring (Dahl & Lundgren, 2006). Additionally, the review pointed out how in several instances of patients who used ACT in comparison to regular CBT, patients actively used their values context as a motivation to engage in behavior change which led to improvement in valued life activities, lower pain ratings, and individual goal achievement. These studies show how the acceptance component of ACT, as well as the context-specific structure of the theory, are unique to this treatment and have shown outcomes within the context of chronic pain management.

Acceptance is not the only component of ACT that is used for chronic pain management. Among the methods used in ACT treatment for chronic pain are those found in CBT such as exposure and behavioral activation, but also novel methods such as greater uses of exposure, mindfulness, psychological flexibility skills, and family systems techniques. In several reviews, ACT has not been shown to be either inferior or superior in efficacy when compared to current established approaches such as CBT (McCracken & Vowles, 2014). One study found that activity persistence was associated with better functioning over time, whereas patients who attempted to control their response to pain experienced greater difficulty in functioning over time (McCracken, Vowles, & Gauntlett-Gilbert, 2007). The same study also reported that help

seeking behaviors and attempts at pain control were associated with greater degrees of disability, and that pain control attempts were specifically associated with greater pain, psychosocial disability, other disability, and pain-related anxiety. This study supports the acceptance, flexibility, engaging and refraining methods supported by ACT and helps to show how what may seem like adaptive behaviors can actually serve as patterns of avoidance than then restrict a patient's daily functioning.

A meta-analysis and systematic review of 22 studies with a total of 1235 patients who reported having chronic pain found that patients with chronic pain responded reasonably well to acceptance-based therapies (Veehof et al., 2011). The review cited strategies that allowed participants to learn how to let go of pain control strategies and accept pain as a daily part of their lives as particularly important in the moderate effect sizes found for decreases in pain intensity.

Additionally, it is worth mentioning that ACT has been listed in APA's Division 12 as an empirically supported treatment for general chronic pain with "strong research support" to back it up. APA's Division 12, the Society of Clinical Psychology, has deemed ACT as making improvements that are specifically mediated by the therapeutic processes outlined in the underlying therapy, which means to say that ACT has specific and unique therapeutic components and methods that underlie its success in chronic pain treatment that is not found in other therapies (Society of Clinical Psychology, 2016).

Mindfulness-based approaches. Mindfulness-based approaches fall into a variety of categories, methods, and definitions underneath the family of CBT, but they are united by three core features. The first core characteristic of these interventions is to observe the reality of the present by paying attention to the objective qualities of the experience or situation existing in

one's inner or outer world. The second core characteristic is to maintain one's attention of a single aspect of awareness (such as one's breath) and accepting it without acting, judging or elaborating on what it may mean. The third core characteristic is that one should remain open to everything that is salient, with the added caveat that one must do so without attachment to any particular viewpoint or outcome (Reiner, Tibi, & Lipsitz, 2013). Overall, mindfulness-based approaches aim to have on pay attention to the present moment with an attitude of acceptance and openness, encouraging deliberate and non-evaluative contact with events that are happening here and now. The way these approaches map onto the treatment of chronic pain is through encouraging the improvement of self-management of chronic pain patients by suggesting to patients that being mindful without specifically changing or targeting pain intensity may be therapeutic by helping one to step back and reframe their experiences (Reiner, Tibi, & Lipsitz, 2013), (further explanation of the possible mechanisms of change involved in mindfulness-based interventions can be found in Figure 2, Appendix A).

Mindfulness, pain, and the brain. There have been a couple of studies on the way the mechanisms emphasized in mindfulness-based interventions specifically play out in brain function and the way these mechanisms interact with pain perception. Wright and Schutte (2014), collected a sample of 200 Australian participants with chronic pain who were asked to complete various measures as part of an online study that assessed concepts such as trait mindfulness, pain self-efficacy, and the affective, sensory, and intensity aspects of pain. In this study, greater trait mindfulness was significantly associated with less perception of pain and more pain management self-efficacy. Mindfulness was also shown to be connected to positive emotional functioning and effective behavioral regulation, and more pain management self-efficacy and higher emotional intelligence was significantly associated with less perception of

pain. There was a full mediating effect with pain management self-efficacy being a mediator between mindfulness and pain. This means that pain management self-efficacy in part explains the relationship between mindfulness and pain, so that when one has higher mindfulness and better pain management self-efficacy, one has less of an experience of pain. Therefore, the management of one's emotions is one of the most relevant factors in pain management and the experience of pain. This relationship suggests that the connection between greater mindfulness and less pain experience could be due to mindfulness approaches providing foundations for emotional functioning and behavioral regulation, which in turn change and influence the experience of pain.

Another study focused on specific brain mechanisms that supported the modulation of pain through mindfulness meditation (Zeidan et al., 2011). Participants who underwent the study engaged in classes about mindfulness meditation and showed an overall increase of 14% in mindfulness skills after their meditation training. Once the training was over, participants were asked to undergo a series of fMRI brain scans. The researchers found that when subjects attended to their breathing (the control) there was no change in pain intensity or pain unpleasantness ratings (with pain produced through noxious stimuli such as electricity or heat) observed when compared to rest fMRI brain scans. However, when participants engaged in mindful meditation there was an average of a 40% reduction in pain intensity ratings when compared with rest and a 57% reduction in pain unpleasantness ratings when compared with rest. Overall, decreases ranged from 11 to 70% for pain intensity and 20 to 93% for pain unpleasantness ratings for participants. Areas that were related to self-regulation of pain such as cognitive control, emotional regulation, and interoceptive awareness were shown to be more active when participants engaged in meditation than in the control or rest conditions. Researchers for the

study suggested that because meditation likely alters pain by enhancing cognitive control while reframing the context of the experience, the interactions between expectations, emotions, and cognitive appraisals that give rise to sensory experience can be regulated through meditation and mindfulness' ability to nonjudgmentally sustain focus on the present moment. This mechanism is likely what gives rise to the positive relationship between the meditative and mindfulness experience and pain relief.

Mindfulness for the treatment of chronic pain. A study conducted in 1984 by Jon Kabat-Zinn is what launched the idea of using mindfulness meditation for chronic pain patients. In his study, 51 chronic pain patients who had not improved with traditional medical care completed a 10-week course where mindfulness meditation practices were taught once a week for two hours, and then were followed-up with several times afterwards. For the 10/51 patients who completed a follow-up during cycle two, there was a 51% reduction in pain index rating, and for the 24/51 patients who completed a follow-up during cycle three there was a 48% reported decrease in pain index rating. Overall, in each cycle more than 50% of the patients who filled out follow-up questionnaires reported greater than or equal to 33% reductions in both present pain and general body problems, and approximately 50% reported themselves as being in the "moderate to great improvement" category. There were also reductions ranging from 29-46% recorded for mean number of medical symptoms, with sufficiently reduced symptoms over the 10 weeks of intervention. These findings led the researcher to conclude that patients were exercising self-regulation and wellness behaviors, in part due to the intervention introduced. Some limitations of the study were the lack of matched comparison groups (Kabat-Zinn, 1984). Thankfully, since that report there have been various trials and studies done on the effect of mindfulness-based approaches on chronic pain patients.

Given that mindfulness specific mechanisms have been linked to emotional regulation and the decreased sensory experience of pain, it is not too surprising to find support for this branch of CBT in recent literature with chronic pain patients. One critical review of the literature on mindfulness-based approaches to chronic pain treatment analyzed 16 studies with 1,404 total patients (Reiner, Tibi, & Lipsitz, 2013). In most of the studies reviewed (10/16) there was a significant decrease in pain intensity for the mindfulness-based intervention group, with an altogether median effect size found in favor of mindfulness-based approaches. These findings were consistently stronger for studies that were limited to clinical pain (9/11), and on average the controlled trials (6/8) revealed higher reductions in pain intensity for the mindfulness-based groups when compared to the control. Despite the positive results found within this critical review, researchers mentioned that there was a lack of high-quality studies included in the literature analysis, with only one study meeting standards for a “high-quality” rating and only two studies meeting the standards for “medium-quality”.

Another positive systematic review showed small decreases in pain intensity when compared to all types of controls in 30 randomized-controlled trials for both short-term and long-term follow-ups (Hilton et al., 2017). When the percent change in pain symptoms from baseline to follow-up for mindfulness meditation and comparison groups was calculated the mean percent, change was double that of control groups for mindfulness meditation, showing double the decrease in pain symptoms for the treatment. However, the researchers stated that many of the trials reviewed presented small sample sizes, had possible publication bias and that there was substantial heterogeneity among studies which may have resulted in the low quality of evidence.

A study performed in the U.K. that analyzed 105 chronic pain patients had similar positive results for mindfulness therapies (McCracken, Gauntlett-Gilbert, & Vowles, 2007). The

study found that mindfulness was positively correlated with acceptance and negatively correlated with measures of pain, emotional distress, and disability. Patients who reported on average more mindfulness tended to report less pain and pain-related distress, less depression and pain-related anxiety, less disability, fewer problems with cognitive functioning, and fewer medications related to pain. Specifically, behavior patterns that were described as “mindful” significantly predicted physical, social, cognitive and emotional functioning, as well as medication use in patients that were seeking treatment for chronic pain. These findings support the idea that mindfulness is positively associated with emotional functioning and well-being and is negatively associated with physical symptom complaints. The study also supports the idea that mindfulness-based interventions are broadly effective for patients that experience chronic pain. Researchers on the study proposed that the way mindfulness leads to behavior patterns that encourage individuals to be less caught up in distressing thought contents and/or emotions may be the key to what makes the treatment effective for chronic pain.

One neuropathic chronic pain patient in a case study found clinically meaningful reductions in pain intensity at post-intervention after 12 weeks of mindfulness meditation practice (Brown & Becerra, 2017). Unfortunately, the reduction was not maintained at follow-up. Researchers believe that this may have been due to the patient ceasing regular mindfulness practice once the 12-week intervention was over. This suggests that though mindfulness meditation may be effective in the short-term, that long-term practice commitment must be made in order for efficacy of the treatment to be maintained. This long-term commitment could take the form of duration spent practicing or the regularity of the practice and implies that the practice itself mediates the effects of mindfulness on chronic pain. Researchers hypothesized about two possible mechanisms of change that arose from the meditative practice. One was that the

reductions in pain intensity were mediated by the detachment of emotional correlates of pain, which in turn then mediated self-regulation and an improved quality of life. This mechanism suggests that mindfulness meditation allows one to detach emotionally, lessening the impact emotions have on the regulation of pain, and therefore allowing for higher self-regulation abilities which lead to an improved quality of life. The other theorized mechanism of change was the possibility that reductions in pain intensity were mediated by more valued action and thus improved quality of life. This mechanism suggests that the reductions in pain intensity came from action that was more deliberate and goals-based (i.e., responding and taking action towards your goals rather than responding to any stimuli; engaging in actions that are goal-oriented and simply being aware of other stimuli), which then could lead to an improved quality of life (Brown & Becerra, 2017). These proposed mechanisms of change take into account the biopsychosocial perspective and the psychological flexibility model.

Similarly, Chiesa and Serretti (2011) conducted a systematic review done on mindfulness-based interventions in 2011 found that mindfulness-based interventions fostered increases in pain acceptance and coping. Overall, 5/7 studies that reported on pain reported an improvement in pain perception higher than that observed in waiting list or education control groups. The mindfulness interventions were found to be equal to or better than controls and were found to be useful in pain management without modifying the actual pain itself. Like other studies mentioned, the critical review reported that mindfulness-based interventions may target specific psychological features associated with chronic pain that may have led to the increase in pain acceptance and coping without real modifications to pain itself. Some limitations of the review were the small sample sizes found in studies, lack of randomization, and lack of

commonalities in terms of techniques, programs, and duration across studies. Additionally, subjects were often female and white.

Overall, mindfulness-based treatment seems to have a strong base of evidence supporting its use in chronic pain management. Additionally, there are several studies that point to specific mechanisms within the mindfulness-based treatments that lead to the outcomes seen in the studies. However, one large limitation of this section of research is that several critical reviews have pointed out the lack of high-quality studies, possible publication bias towards meaningful significant results, and heterogeneity among studies that make it harder to generalize results throughout several studies.

Limitations and Considerations

There are a few limitations to the psychological research that has been outlined in this section. First and foremost, a lot of research has been done in this field but at the same time a lot of the research has not been a) composed of large randomized controlled trials that can more rigorously stand up to criticism and be interpreted with less caution, and b) has not been specifically finessed and honed in on to look at mechanisms of change within theories and models used that can then lead to developments in research, treatments and therefore outcomes. In the case of point A, there are a lot of studies that have been conducted but many of them had small sample sizes, a lack of randomization, were heterogeneous in their sample, hard to generalize to outside groups, or had treatment protocols that were not well defined or even laid out causing replicability and interpretability of results to be an issue. Additionally, many of the studies had differences in treatment protocols, duration, and techniques. In the case of point B, many of the studies done and outlined here focused on whether a certain treatment stood up against placebos but rarely did any of the studies go further in their research to assess what

mechanism of the treatment used was the cause for the changes seen in the patients and the differences in outcomes.

Some important considerations to have in mind with psychological research on chronic pain management have to do with the outcome measures used and how the treatments are administered. It has been mentioned in several studies that the correct way to measure the efficacy of psychological treatments on chronic pain may not have to do with pain intensity or pain relief. Rather, the outcomes measured should focus on changes in returning to daily activity or changes in the interference of pain with daily life (Veehof et al., 2011). This is because many psychological interventions do not target the sensory experience of pain specifically but rather target the mindsets and emotions surrounding the experience of pain to change the effect that the pain has on patients. Therefore, the outcome measures of pain intensity or pain relief are not representative of the effects of the treatments on chronic pain, especially since psychological treatments do not aim to specifically eliminate pain (a goal that is usually unrealistic in the first place).

In terms of the way the treatments are administered, the competency of providers who are planning, administering and providing the psychological intervention has been shown to greatly impact treatment outcomes, as does the trust and transparency between patient and provider (Yang, McCracken, & Moss-Morris, 2016; Tang, 2018). Additionally, depending on the population, treatment should be adapted to meet the needs of the population. For example, in the geriatric population there may be needs for change in pacing of delivery, amount of repetition, different treatment materials and evaluation scales may need to be designed, and cognitive impairment in patients should be considered before administering treatment (McGuire et al., 2014).

Chapter 4: Physiological Treatment for Chronic Pain

The last form of chronic pain treatment that will be covered in this systematic review is physiological treatment. Often times physiological treatment is administered either by itself or in addition to psychological treatment, and many administrators of physiotherapy may have psychological training background. Physiological treatment is often considered as a line of defense on its own in order to avoid surgical procedures or the use of pharmacological therapy. The models for how the physiological approach work are those of the pharmacological therapy because they essentially target the same thing as the pharmacological approach - pain relief. However, in addition to pain relief, many times other outcomes are desired in this approach such as mobility, range of function, interference of pain in daily life, and return to activities and work. In this section I will begin by outlining those who are in charge of administering treatment under the umbrella of physiological approach and will then go on to discuss the specific modalities of treatment used in this approach. In the physiological approach, the theories of pain and how the treatments work are the same as those found in the pharmacological approach – biomedical theories and biopsychosocial approaches to pain.

Service Providers for Physiological Treatment and Scope of Care

Physical therapists, occupational therapists, and chiropractic doctors. While there are many types of service providers, primary caretakers, and doctors that can provide the services that I will discuss in this section, I have narrowed it down to physical and occupational therapists, and chiropractic care providers in order to narrow the scope. I will explain the way in which these care providers are similar and different, and then go on to do an overview of the ways in which they may provide physiological treatment for chronic pain.

Physical therapists (PTs) are licensed health professionals (Doctor of Physical Therapy) that focus on reducing pain and improving or restoring mobility of their patients. PTs focus on education of patients in order for them to prevent or manage their condition and develop individualized plans for their patients using treatment techniques that actively promote the patient's ability to move, reduce pain, restore function, and prevent disability (American Physical Therapy Association, 2015). They can also help to prevent the loss of mobility by developing fitness and wellness programs for their patients. PT interventions include, but are not limited to, a variety of techniques such as therapeutic exercise, manual therapy (mobilization and manipulation), the use of electro-therapeutic modalities, physical agents, and mechanical modalities (American Physical Therapy Association, 2011).

Occupational therapists (OTs) are health professionals that promote health and well-being through occupation, with a primary goal of enabling people to participate in everyday activities in life (World Federation of Occupational Therapists, 2012). OTs help patients enhance their ability to engage in the occupations they desire or help them by modifying the occupation or environment they engage with in order to better support their occupational engagement. Occupation in this definition is referring to the everyday activities that people do as individuals, within their family, and with communities in order to occupy time and to bring meaning to their everyday life. OT intervention focuses on programs that are person oriented and environmental in order to facilitate the performance of everyday tasks. Examples of techniques used in OT include providing equipment to facilitate independence, reducing environmental barriers, and to provide resources to lessen stress.

Doctors of Chiropractic (DCs) are health care professionals whose focus is on disorders of the musculoskeletal system and nervous system, and the effects that these disorders may have

on general health (American Chiropractic Association, 2018). Usually chiropractic services are implemented in order to treat neuromusculoskeletal complaints such as back and neck pain, pain in the joints of the arms or legs, and headaches. Chiropractic techniques are drug-free and include therapeutic and rehabilitative exercises, education on nutritional, dietary, and lifestyle choices, and other diagnostic interventions. A common technique used is manipulation.

Physiological Treatments

General services and outcomes. Most physiological treatment providers use a combination of techniques in order to achieve treatment outcomes. For this reason, this section will outline papers and studies that use multiple modalities in the treatment of chronic pain (or that do not specify techniques used in treatment) and later sections will outline papers and studies that are more specific in the modalities used for the treatment of chronic pain.

In one study that surveyed 588 individuals with chronic low back pain, researchers found that 29.7% of the sample surveyed through the phone had seen a physical therapist in the past year for a mean of 15.6 visits (Freburger, Carey, & Holmes, 2011). Of the interventions used, exercise intervention was the most common used with over 75% of the population receiving it, therapeutic massage and spinal manipulation was received by less than 20% of the population, and heat or cold and electrical stimulation modalities were used moderately frequently with 27-50% of the population receiving this intervention. Of the interventions used, exercise and therapeutic massage and spinal manipulation have evidence-based support for their effectiveness, whereas the use of heat or cold and electrical stimulation has unclear evidence-based support for its effectiveness. 7% of the population also mentioned receiving traction, and about 25% of the population received a corset or brace - both which have been shown to be ineffective interventions for chronic low back pain. Higher physical function scores were positively

associated with physical therapy use, indicating that individuals who saw a physical therapist had higher levels of function. These findings should be interpreted with caution because they are correlational rather than pointing at causation. The presence of lower-extremity pain and having had surgery was associated with physical therapy use, and duration of the problem was inversely related to physical therapy use. This research indicates that those who have had chronic pain for longer may be less likely to engage in physical therapy.

A similar study was conducted where the effectiveness of physical therapy for the management of chronic spine disorders (often associated with chronic pain) was assessed (Freburger, Carey, & Holmes, 2006). Researchers used the National Spine Network database to find patients who had received physical therapy (intervention group, 44% of patients included) and those who had not received physical therapy (control group) between 1998-2002. A total of 4,479 patients were included in the study and 1,362 pairs were matched between intervention and control group based on demographics, pain, location of disorder and severity (leaving 31% of patients unmatched in the study). Additionally, a propensity score was calculated to indicate patients that displayed characteristics that made them more likely candidates for physical therapy. Researchers found that the intervention group improved significantly in physical function, role physical and bodily pain scores, though the significance did not reach clinical relevance. However, the improvement in outcome scores was even greater in the intervention group that had higher propensity scores (these scores reached both clinical and statistical significance). Results found indicate that patients who were more likely candidates for physical therapy and that ended up receiving physical therapy improved clinically and significantly in their scores for physical function, role physical and bodily pain, ultimately showing that physical therapy was effective treatment for the management of chronic spine and pain disorders,

especially in those who are ideal candidates for physical therapy. A possible reason for why clinical significance was not found between the intervention and control groups despite being statistically significant is that one third of the patients who were included in the study reported spine and pain problems for over three years, and that only 69% of those who received physical therapy were matched to a control participant. Additionally, the outcomes were measured using self-report measures and there was some missing data from the subjects used.

Another study focused on chiropractic services for the management of chronic pain (Wilkey et al., 2008). The study done was a pragmatic, randomized, controlled trial that focused on comparing chiropractic management and pain clinic management in the United Kingdom for patients with chronic low-back pain. Of those who completed the trial, 11 were randomized into the pain clinic where they followed normal treatment protocols as established by the pain clinic, and 16 were randomized into the chiropractic group where participants followed an equally unrestricted and normal treatment regimen. The total treatment period was for 8 weeks and each participant had a maximum treatment number of 16. After eight weeks, the improvement in disability for the chiropractic group was statistically and clinically significant with participants scoring 5.52 points higher than the pain clinic group. Improvement in pain intensity at week 8 also swayed in favor of the chiropractic group with a statistically higher improvement of 1.79 points above the pain clinic group (through the researchers did not mention if this increase was clinically relevant for the scale used). Both groups showed a reduction in disability overall. The study showed that chiropractic management offered some benefit to patients suffering with chronic low back pain in the form of reduced perceived pain and reduced disability. It should be noted that one large limitation of the study was that mean attendance for the treatment in the pain

clinic group was 1.9 sessions compared to the 11.3 sessions attended in the chiropractic intervention group.

Overall, chiropractic and physical therapy management of chronic pain has been shown to be effective in some regards, and somewhat well used among the chronic pain population. Next, specific therapies and modalities of treatment will be explored in the context of physiological treatment for chronic pain management.

Exercise therapies. A big part of physiological treatment for chronic pain is exercise therapy. This therapy includes strength-training programs, cardio, stretching regimens, and mobilization and stabilization exercises.

One meta-analysis that reviewed 43 trials (with 3907 total participants) on chronic pain in nonspecific low back pain populations found that exercise therapy was slightly effective at decreasing pain and improving function (Hayden et al., 2005). This effect was magnified within the healthcare population (those seeking primary, secondary, or tertiary care within specified healthcare centers) as opposed to the occupational population (patients presenting to occupational healthcare facilities), or those from a general or mixed population (for example, patients who were recruited through newspaper advertisements). The studies showed a pooled weighted mean improvement of 10.2 points for exercise therapy compared to a pooled weighted mean of 5.93 points for no treatment in pain outcomes. Smaller improvements were found in functional outcomes, with a positive effect of 3 points for exercise therapy compared to 2.37 points for no treatment. Both improvements, though small, were considered statistically significant. For healthcare populations, the mean improvement jumped to 13.3 points for pain outcomes and 6.9 points for functional outcomes. These improvements were considered statistically significant as well and showed larger effect sizes. This data suggests that patients

that were assessed and studied within a healthcare setting showed greater improvement in their pain and functional outcomes, though overall, patients who received exercise therapy had small but significant improvements in their pain and functional outcomes. Researchers noted that there were a few limitations with the meta-analysis, primarily due to a lack of high-quality studies, and a lack of further outcome measure reporting past simply reporting on pain intensity.

A systematic review conducted on nine randomized controlled trials involving 1105 patients with chronic low back pain found strong evidence that exercise therapy was more effective than usual care by a general practitioner (Tulder et al., 2000). Strong evidence was also found to support that exercise therapy and physiotherapy (exercise therapy in combination with manipulation, temperature and electrical stimulation, etc.) were equally effective for chronic low back pain. Limited evidence was found in regard to exercise therapy providing better pain relief in comparison to manual therapy. There was conflicting evidence as to which exercise, extension or flexion, was more effective for chronic low back pain. Effectiveness for chronic low back pain was measured as being helpful in allowing patients to increase return to normal daily activities and work. This study supports the continued idea that exercise therapy can be a meaningful tool for chronic pain management, especially for those who are averse to pharmacological treatment or other more invasive treatments.

Overall, exercise therapies have been found to produce at least small yet significant effects on pain reduction and to allow patients to return to normal daily activities. This evidence is particularly important because exercise therapy is a good alternative to pharmacological therapies which have significant side effect profiles. Additionally, exercise therapy is a type of therapy that can be carried out on one's own (after proper instruction and care) and can therefore be more cost effective than other services used for chronic pain management.

The importance of education. One of the main ways that these service providers care for their patients is through the prescription and recommendation of exercise to strengthen, build, and stabilize the body. Along with exercise there is usually an element of education that I will highlight in this section. Though education is not a physiological treatment, it is an important part of the care that these service providers give to their patients, and therefore should be noted and discussed (Darnall, 2019). Education can take the form of teaching patients new exercises but can also include education about ways to live healthier through gradual increase of exercise, better food intake, and learning about the musculoskeletal or neurological condition that the patient has more in depth, so the patient can have more agency in their care and more information about their body. Often education is an important part of the exercise component because it teaches patients how to move their body correctly and how to move their body despite pain that they may feel or how to modify their exercises due to their current limitations.

One study conducted on 130 participants with chronic pain due to scoliosis showed that exercise and education (in the form of active self-correction, physiotherapy, cognitive-behavioral techniques, and task-oriented exercises) compared to a control with general exercise therapy had a significant 12% greater decrease in disability scores, and an almost one-point decrease in their pain. There was also evidence of significant improvements in each domain of quality of life, including function, pain, self-image, mental health, and satisfaction with care. A similar study conducted on adolescents with scoliosis showed similar results about exercise in conjunction with education (Alanazi, Parent, & Dennett, 2018).

Another study, focused on preventative care, found significant implications regarding the importance of exercise paired with education and cognitive-behavioral techniques (Meyer, Denis & Berquin, 2018). Researchers underwent a systematic review of 13 articles that corresponded to

nine different studies in an effort to determine clinical and economic effectiveness of secondary-prevention stratified strategies of chronic musculoskeletal pain. The studies reviewed found that primary and secondary care setting that had treatments that were individualized to patients was more effective from a clinical and economic standpoint than “one-size-fits-all” type treatments. Additionally, the studies showed that effect size of treatment was proportional to risk level. That is, low-risk patients showed no benefit with interventions that supplemented usual care, but medium and high-risk patients showed improved physical and emotional functioning when usual treatment was complemented with an exercise component that included education and cognitive-behavioral techniques (most studies were conducted by physiotherapists that had psychological training and background which was interwoven in their physical therapy treatment). There was also an earlier return to work found in this population. Another outcome from these studies was that a relatively small number of treatment sessions was sufficient in order to achieve good results. However, better outcomes were observed in the short term than in the long-term, which may suggest that additional treatment session would be beneficial in order to solidify and build upon what had been learned or practiced in earlier sessions. Though the studies reviewed focused on individuals with acute or subacute musculoskeletal pain of non-cancer origin, there are implications found in this study that may affect the population of individuals who have already developed chronic pain or are close to doing so. If higher risk participants showed higher improvement scores, then it is possible that those who have already developed chronic pain may benefit even more from this type of treatment.

Though education may seem like an obvious incorporation into most treatment management options, it has specific benefits of its own that should not be overlooked. Education was shown to enhance and increase benefits found in exercise therapy, specifically for patients

who were at higher risk of developing chronic pain. This evidence suggests that education may be an important preventative tool for chronic pain, as well as an important tool in the management of chronic pain itself to help improve results of treatment plans.

Manipulation therapies. Manipulation is defined as a form of manual therapy which entails the movement of a joint past its usual end range of motion, but not past its anatomic range of motion (Tulder, Koes, & Malmivaara, 2006). This usually means manually moving a joint past its restricted range of motion. Manipulation therapies help to release entrapped synovial folds, relax muscles, unbuckle and reposition segments that have been displaced, mechanically stimulate areas, and to reduce muscle spasms.

In a randomized, controlled trial conducted on chronic pain patients with low back pain, manual therapy was shown to be more effective than exercise therapy (Aure, Nilsen, & Vasseljen, 2003). The study was conducted on a total of 49 patients who had chronic pain that had caused them to be on sick leave from work for more than eight weeks. Sixteen treatments over the course of two months were administered to the patients, who were randomized into either a manual therapy or exercise therapy group. There were significant improvements found in both groups, but manual therapy showed significantly greater improvements in all outcome measures, including pain, functional disability, general health, spinal range of motion, and return to work. At the end of the eight weeks, 67% of the patients in the manual therapy group and 27% of the patients in the exercise therapy group had returned to work. These overall significant effects were reflected in the one-year follow-up as well, and later review of the data showed that the effects were largely gained during the eight-week treatment period. This data suggests that 8-weeks of manual therapy are sufficient to cause significant improvements in multiple health

outcomes, including decreasing pain, compared to exercise therapy. Despite the positive results, a large limitation of this study was that there was no blinding done.

A unique case study supporting the use of chiropractic manipulation treatment focused on a 36-year-old male with low-back pain, right leg pain and testicular pain (Rowell & Rylander, 2012). The patient reported that he had had the pain with sudden onset five years ago and that it was gradually worsening. He underwent 19 treatments over eight weeks of flexion-distraction of the lumbar spine, a chiropractic manipulation treatment. Overtime the patient reported a gradual decrease of pain during the course of care. After four weeks the patient reported that high low-back pain was decreased, and his leg pain was gone. The testicular pain was improved after the first treatment and was reportedly gone after three weeks of treatment, an effect that lasted through a three- and six-month phone follow-up. Overall, the patient reported improved low-back pain and complete remission his leg and testicular pain. This patient case study showcases the ways in which manipulation therapies provided by a licensed professional can be helpful in alleviating and treating long term chronic pain, even when other measures have not worked. A limitation of this study is that an MRI was not obtained from the patient that was recent and therefore it is hard to draw conclusions about the mechanism of the pain and how the manipulation treatment was specifically useful in the alleviation of the pain. Future studies assessed should make sure to take careful imaging and tests in order to tease out the mechanisms in which manipulation treatment alleviates pain so that it can be modified and bettered. Another limitation is the fact that this study was a case study and therefore may be hard to replicate. This limitation does not rule out the helpful use of manipulation, however.

Manual therapy has been shown to decrease pain and improve several health outcomes. There is even evidence to show that manual therapy may be more effective than exercise therapy

in some cases. Despite this evidence, however, there are limited studies surrounding the use of manual therapies in chronic pain, and therefore more large scale randomized controlled trials should be conducted in order to further support the use of manual therapy in chronic pain management and treatment.

Heat, STEM, cold, and other sensory manipulations. One way to treat chronic pain physiologically is through the use of temperature stimulation, electrical stimulation, and other sensory manipulations. These manipulations and stimulations are usually directed at increasing blood flow, increasing endorphin output, and decreasing swelling and inflammation.

One study on the effects of supplemental heat therapy with multimodal treatment was conducted on 176 patients with chronic low back pain (Freiwald et al., 2018). These patients were randomized to undergo 12-weeks of multimodal treatment (with one to two sessions a week) with or without a supplemental heat wrap (that provided mild heat) that was to be worn on the lower back for over eight hours after each treatment. Results showed that range of movement as well as strength parameters of the trunk improved for both conditions, with those who wore the supplemental heat wrap showing significant further improvements in strength parameters regarding extension, and rotation to the right and left. Though this study did not measure pain intensity, it can be said that increased range of movement and strength could increase quality of life due to more mobility, and researchers noted that increased range of motion and strength was correlated with increased condition (better overall outcome). One large limitation of this study is the amount of time that patients had to wear the supplemental heat wrap (8 hours). It would be worth it to research if heat therapy applied for less time would show similar results.

There were two meta-analyses that I was able to find regarding electrical nerve stimulation (ENS) in chronic musculoskeletal pain. ENS refers to the application of electrical

energy to peripheral nerves through electrodes, and it is administered through various waveforms, amplitudes, and frequencies (Johnson & Martinson, 2007). Johnson and Martinson (2007) analyzed 38 studies in 29 papers with 1,227 total participants and found significant decreases in pain with ENS therapy. Using a random-effects model, researchers found that for all studies combined, ENS reduced pain significantly more than placebo. On average, the pain relief provided by ENS was nearly three times that of pain relief provided by placebo. Researchers concluded that ENS, a treatment that is covered by most major insurers, should be made available to most chronic pain patients, as it provides significant pain relief on its own and has little to no side effects. Similarly, Jauregui (2016) found that in 13 studies (encompassing 267 total patients) ENS therapy demonstrated a significant improvement on pain reduction with a mean difference of 0.844. Interestingly enough, when treatment duration was taken into account, patients who were treated for less than five weeks had significant pain reduction compared to those who had been treated for over five weeks (who had decreased pain, but the effect was not found to be significant). The researcher in this study also concluded that ENS should be considered an easy, cost effective, non-invasive and non-harmful modality to manage chronic pain.

Evidence for ENS therapy is strong regarding chronic pain management. Two large meta-analyses have found significant improvements in pain reduction and reported that ENS should be considered in routine chronic pain management. For heat therapy the evidence is less convincing. There was one relevant study that was found on heat therapy for chronic pain management, and it did not focus on pain intensity as an outcome measure. Additionally, the heat therapy wraps had to be worn for eight hours after each multimodal treatment to see the improvements found in

the study. Future research into the area of temperature stimulation for chronic pain management should be looked into before any specific conclusions can be drawn on the matter.

Limitations and considerations

There are a couple of limitations concerning physiological treatment of chronic pain. One of limitations is that mean attendance can be low in intervention groups, and that there is a general lack of high-quality studies (and in some cases a lack of general research in specific areas). More research needs to be done within physiological treatment areas to assess their efficacy in the treatment of chronic pain. There especially needs to be more research into manual therapies and temperature stimulation treatments for chronic pain management, as these specific areas of treatment seem to be particularly underrepresented within the literature.

A large limitation of physiological studies is the use of self-report measures. One possible way to combat this is to have reports based on functionality and range of motion, or to assess quality of life. Another large limitation of these studies is the difficulty in blinding. Many times, blinding in physiological studies can be difficult and therefore is not implemented. One way to go around this limitation could be to assign different clinics different treatment interventions. Though this still does not blind the patients or providers, there is less chance for contamination this way.

Additionally, much like the treatments reviewed before, physiological treatment usually ends in improvements in health outcomes, quality of life, and reductions in pain intensity. However, this does not mean that anyone who undergoes physiological treatment will end their regimen pain-free.

Chapter 5: The Possible Solution – An Interdisciplinary Patient-Centered Individualized Approach to Chronic Pain and the Need for Education

Seeing as that no approach seems to bring full analgesic effects and that the approaches seem to be capable of complimenting each other, the enticing and rather rational solution is to adopt an interdisciplinary approach. This entails bringing together different approaches to the management of chronic pain in order to best fit the care of the patient. In a comprehensive literature on interdisciplinary work, Choi and Pak (2006) defined interdisciplinary work as collaborative exchanges between researchers that draw from different areas in order to solve a problem, a profound level of collaboration between researchers of different backgrounds in order to combine knowledge to mutually complete different levels of planned care, and a case where concepts and methodologies are exchanged and integrated in order to result in mutual enrichment. Therefore, interdisciplinary work goes beyond a multi-disciplinary approach because there is interaction between specialties and a comprehensive integration of their work together in order to achieve a common goal (in this case, helping a patient manage their chronic pain).

The interdisciplinary approach is best reflected in the biopsychosocial model, which recognizes that there are multiple influences that interact dynamically within each person, and identifies that psychological, behavioral, and sociological factors make up each individual unique pain experience (Novy, 2004; Gatchel, Howard, & Haggard, 2011). The biopsychosocial model also mentioned the three main comorbidities found most commonly within chronic pain patients: mood disorders, anxiety disorders, and substance abuse disorders. Researchers, Dersh, Polatin, and Gatchel (2002), found in their systematic review of chronic pain and psychopathology that the possible prevalence of major depressive disorder among chronic pain patients was 30-54%. The possible prevalence for major anxiety disorders was estimated to lie between 16.5-28.8%, and the prevalence of personality disorders to lie between 31-81%. In the

case of substance abuse disorders, the lifetime rate for chronic pain patients ranged from 23-41%. This data is particularly important to consider because a collaborative interdisciplinary approach, in which patients are evaluated and treated by providers from multiple areas of expertise (such as psychologists, therapists, social workers, primary care providers, etc.), would best help patients to address the multiple factors that interact to cause and perpetuate this pain, including the main comorbidities found with chronic pain. All in all, this method would allow patients to get the best individualized care that they deserve, in order to treat the multiple factors contributing to pain, and to ultimately have a better quality of life and better assistance in their management of chronic pain. Again, this does not guarantee that patients will come out of their treatment pain-free, but rather the interdisciplinary approach hopes to target as many factors contributing to the pain experience of an individual as possible in order to enhance their quality of life and allow the patient to engage in as many activities as they desire.

Investigators, Gatchel, Howard, and Haggard (2011), suggested that interdisciplinary care is the most treatment effective and cost-effective way to manage chronic pain. In their systematic review that gave an overview of the biopsychosocial model, the researchers also touched upon interdisciplinary rehabilitation outcomes. They found that interdisciplinary care led to better outcomes in chronic pain patients, including higher reductions in pain, more functional mobility, and faster return to daily activities. Similarly, Turk and colleagues (2005) published an article with the American Pain Society proposing that interdisciplinary pain management provides “optimal care for patients”, specifically those who are suffering from noncancer chronic pain. They also highlight the importance of team members and stakeholders (institutions, those with pain, and care providers) in supporting, encouraging, and demanding this comprehensive

approach to pain management, due to an interdisciplinary approach being in everyone's best interests.

In addition to an interdisciplinary approach I also argue that the best approach is a patient-centered individualized approach, owing to the fact that no single treatment will be fully beneficial to every person and therefore treatments should be catered to the needs of each patient. Woolf (2004) wrote that the future of pain management would involve identifying mechanisms of pain in individual patients and addressing said mechanisms. Along similar lines, Rothwell (2005) argued that evidence from clinical trials often do not reflect the needs of real-life patients and that we should stop trying to fit patients into a "one size fits all" role when he posed the question, "To whom do the results of this trial apply?". This means that some patients may need more physiological treatment, others will benefit more from an emphasis on psychological treatments, and so on, and that evidence from randomized controlled trials can help guide treatment but are not the end all be all, so treatment regimens should ultimately be designed for specific patients (in other words, should be individualized for each patient). The reasoning behind combining these therapeutic approaches is that one may compensate for another's shortcomings, they may complement each other and therefore bring longer lasting and stronger effects, and that this approach allows for more individualized care of each patient and their psychological, physiological, and social needs. Each therapy alone may be insufficient to cover a patient's needs, but together the approaches can combine to bring enhanced therapeutic effects in a cost-effective manner. For example, a patient may need to use less drugs because they are complementing their treatment with psychological therapies that teach acceptance of pain and physiotherapy that encourages moving despite pain and continuing to engage in different activities. The patient in this scenario would not only benefit from having to use less

pharmacological therapies but would also benefit from being encouraged to continue engaging in activities which would ultimately bring social satisfaction and life satisfaction by combating isolation.

Patient-Centered: What it Really Takes

Though a brief overview of what being patient-centered concerns has been outlined, I would like to use this section to go more into detail as to what this approach truly entails.

To be committed to a patient-centered approach the whole healthcare system must change. The idea behind the approach is to make sure the patient is the one with the agency - meaning that the patient must be informed at all times, must be the one making the final decisions, and must have access to material that they can understand. Additionally, this calls for medical professionals to coordinate with each other, to not compete for dominance in the treatment of a patient, and to truly collaborate and be transparent in their dealings with each other and with the patient. This type of practice is usually referred to as interprofessional practice (Stumbo, 2018). Ultimately, interprofessional practice is the idea that health care providers should collaborate with one another in the best interests of the patient they have in common. This means that providers should know the scope of their own abilities, should be in communication, referencing and working with others who have more experience in other scopes of care, and should be referring their patient out to other health care professionals when necessary. Interprofessional practice has a basis in the idea that health care is not a competition at the expense of the patient, but rather it is what it is truly intended to be – health care for the patient that is directed and led by the patient. Therefore, it is important in this approach for the patient to be treated as the leader, the most important person in the health care group, and as an individual rather than a statistic or a number. In this approach the patient should be completely autonomous

in their final decision making and should not feel pressured to engage in certain treatment regimens just because their health care providers recommend it. A patient should have the information necessary to be able to make informed decisions about their self-directed care.

In order to achieve this, two things that must be changed are patient education and the way that health care providers talk to and interact with patients. For example, in the case of patient education, many chronic pain patients have misconceptions about what causes their pain, and this may trigger pain-related fear (Leeuw et al. 2007; Crombez et al., 2012). If a patient believes that there is actual damage to their musculoskeletal system or nervous system that causes the pain, they may catastrophize the situation rather than actually understanding what may be causing their pain. Fearful patients are also more likely to continue searching for biomedical explanations and solutions for their pain, may have a history of dis-satisfactory health care encounters, may strive for pain relief rather than restoration of activities, and may more frequently have comorbid disorders that exacerbate the condition (Leeuw et al., 2007). If a patient does not know where their pain is stemming from or may not be educated in what are realistic goals for their treatment outcomes, they may be more dissatisfied with care if they do not reach complete pain relief (a sometimes idealistic and improbably goal), despite possibly achieving more mobility and being able to return to more activities than before treatment was administered. Similarly, patient education may be preventative by helping those in the acute stage recover rather than develop chronic pain (Leeuw et al., 2007; Gatchel, Howard, & Haggard, 2011).

Along with patient education comes the responsibility of health care providers to change the way in which they present medical information. Inaccessible information can be fear-inducing to patients, and health care providers' face expressions and the use of threatening

diagnostic labels - such as back injury, ruptured disc, degenerative change - may activate a patient's fear network. These inaccessible diagnostic terms may be interpreted by patients as evidence for serious pathology, therefore possibly causing healthcare providers to inadvertently increase the threat value of pain (Leeuw et al., 2007). Language can also impact the way that patients think about and conceptualize their recovery. For example, using a phrase such as "avoid painful movements" can fuel fear in patients and can cause some patients to avoid movement altogether for fear of causing discomfort or what they think may cause "further damage". It is therefore important for healthcare providers to think of alternate ways to talk about the recovery process with patients, and to advise the continuation of normal activities, including work, even when the patient may experience pain (unless absolutely medically inadvisable). Unfortunately, these fear avoidance beliefs are not specific to patients. It has been shown that fear avoidance beliefs of healthcare providers themselves can also induce or strengthen those similar beliefs of their patients, especially for those patients that are likely to be sensitive to minor hesitations or inconsistencies (Leeuw et al., 2007). Therefore, while patient education is a crucial part of how to change the way chronic pain is treated in the healthcare field, provider education on pain models and theories - biological, psychological, and social - is also a very important part of furthering the advances made in the treatment of chronic pain. This also holds for the idea that chronic pain is "always curable". Often, achieving a pain-free state can be unavoidable, and in reality, pain is a natural part of human life. It is important for the healthcare system to realize this and pass this information on to their patients so that patients do not have unrealistic expectations from their treatments. The most important part of chronic pain management is to make sure that chronic pain does not interfere with one's daily life, which is a goal that can be achieved when healthcare providers work together with the interdisciplinary approach.

For these ideas to take hold, as Turk and colleagues (2005) wrote, it is the responsibility of all stakeholders and team members to support, encourage, and demand an interdisciplinary approach. This requires a cultural change to how we view medical professions and the education that healthcare providers acquire. A bottom-up approach could help with this change, such as requiring healthcare providers to take classes on the biopsychosocial model, interprofessional practice, and patient-centered care. This would hopefully influence providers to think more critically about their practice, their interactions with patients, and the way that different social, psychological, and biological interactions are at play in each of their patients. In the realm of chronic pain management, this entails things such as: knowing different risk factors for chronic pain and comorbidities, knowing how to screen patients for possible opioid prescriptions and risk factors for substance abuse, and knowing when to call in psychologists and social workers to help with a patient case. There needs to be infrastructure in place, as well as a demand, for these types of classes to be offered. Part of this means that there needs to be education about how the healthcare system may be flawed in the first place. This would require possible institutional or even governmental (and political) interventions and changes.

Drawbacks to some of these suggestions would be the cost of education, classes, workshops, and so on, as well as the taking the time to implement the changes. However, start-up costs would be marginal compared to the leaps that chronic pain management would take if more providers used an interdisciplinary patient-centered approach. When thinking about the current financial burden of chronic pain – an estimated \$560 billion according to a 2016 report by the National Center for Complementary and Integrative Health – the start-up costs to implement these changes would probably be minimal in comparison to the changes they could make within

the healthcare system, the increased pain management that patients would experience, and the total decrease in medical costs and productivity loss from chronic pain.

An example of an institution that has taken the initiative is Des Moines University, a private university for medicine and health sciences. Des Moines University encourages all healthcare provider students to take part in a diversity health series which covers health disparities in the United States as well as different risk factors depending on culture and ethnic diversity of patients, encourages students to take classes on interprofessional practice, and is beginning to implement a provider education program designed by the National Alliance on Mental Illness for medical students that focuses on giving students a deeper understanding of mental health issues and the way they impact patients and patient outcomes (Des Moines University, 2016; Boose, 2017; Branstad, 2017; Boose, 2018). Though their specific program does not focus on chronic pain, the valuable lessons that students learn through engaging in these programs is helpful for all aspects of health care, including chronic pain management.

Chapter 6: Conclusion

Lingering Problems and Tentative Solutions

There are a few lingering problems in the overall expanse of chronic pain management research. One such problem is the use of self-report measures for most outcome measures. Though self-report measures are in part unavoidable, there should be means to support self-report measures. One such way is through the use of quantitative measures, such as those of sensory pain tolerance and threshold. These measures can be cross-referenced by self-report measures given in studies. Additionally, other quantitative measures such as improvements in range of motion, amount of daily exercise, and amount of activities done in one day that weren't impeded by pain can also help support self-report measures of outcomes such as pain intensity.

These measures can be done by healthcare professionals, and other outcomes such as amount of daily exercise can be verified by technology such as pedometers or by family and friends of the patient.

One limitation of a lot of the research has to do with access to healthcare. Many of the studies conducted were done in health care provider settings or had participants that had access to healthcare (Freburger, Carey, & Holmes, 2006; McCracken, Vowles, & Gauntlett-Gilbert, 2007; Couto et al., 2009; Freburger, Carey, & Holmes, 2011; Krebs et al., 2018). Access to adequate health care can be a large barrier to many people and requires systemic change from the U.S. government or from providers who are willing to provide services in, for example, extremely rural areas that do not have nearby surrounding hospitals or clinics. It is important for the U.S. government and for providers themselves to address these very real issues within the United States.

Another issue within chronic pain management research is the lack of well-defined methodologies and the lack of high-quality research. This problem will be addressed within the “Future Directions of Research” section.

Future Directions of Research

Future directions in the area of chronic pain management research should be focused on the interdisciplinary approach. Additionally, there needs to be more work done to have high quality randomized controlled trials conducted on several chronic pain management treatment areas. There seems to be a lack of high-quality studies, which may be due to a variety of reasons. For example, lack of funding may lead to less participants recruited and therefore underpowered studies. Due to the high financial burden of chronic pain, it is important for the United States healthcare system and providers to invest in research for sound treatments and methodologies for

chronic pain management. There is also a need for better defined regimens for care. Ultimately, there is a need for the answer to the question posed by Tang (2018), “*who with what training should be delivering the treatment in what dosage, format, and sequence?*”.

More research should also be done on education regarding chronic pain and chronic pain management, as well as the outcome of provider network education on patient outcomes. For example, *does education for providers on individualized care or on collaborative interdisciplinary work lead to better patient outcomes? Or does patient education lead to better patient outcomes?* Though there is already some evidence out there that patient education does lead to better patient outcomes (Alanazi, Parent, & Dennett, 2018; Meyer, Denis & Berquin, 2018; Darnall, 2019), there should be more research on best modes of transferring information, how to reach larger audiences (especially in at-risk populations), and how to educate populations that require more specialized care (i.e. geriatric population). It is also important to acknowledge within the healthcare system that totally pain-free states may be unrealistic for a lot of patients, and that is why an emphasis on psychological treatments can be particularly beneficial for chronic pain management.

Overview and Final Thoughts

Dahl and Lundgren (2006) wrote, “When pain was unavoidable, we tolerated it. When pain became avoidable, it became intolerable. What we have created, with all of our painkillers and pain management strategies, is an intolerance and increased sensitivity to pain”. This particular quote does a good job of framing the chronic pain management crisis of searching for total pain relief. It is important that as healthcare providers the system acknowledges that pain is a normal experience of every human’s life and that therefore chronic pain should be assessed more in terms of how impactful and damaging it is to one’s life rather than the subjective pain

that individuals feel. Complete pain relief can be hard to achieve, even with an interdisciplinary approach. This is one of the main reasons that education on pain is so important to aspects of chronic pain management research and to healthcare providers themselves. Additionally, as outlined in the psychological sections, outcome measures for chronic pain management research should not focus solely on pain intensity reductions. Other important outcome measures could include changes in returning to daily activity, time taken to return to work, or changes in the interference of pain with daily life (Veehof et al., 2011). This would do a greater job of 1) managing more realistic expectations for chronic pain treatment outcomes, and 2) better measuring the efficacy of an interdisciplinary approach which would be assessing several parts of a person's pain experience, such as social and psychological factors which cannot be measured through pain intensity.

It is important that as we look forward to the future of chronic pain management that we do our best to educate ourselves on individualized experiences of pain, educating patients on how different factors in their lives influence their pain, and collaborate as a healthcare community to provide the best care to our patients – always making sure that treatment is patient-centered and that the one who calls the shots is the one who is at times the most vulnerable, the patient. This can be achieved through an interdisciplinary approach, bringing together pharmacological, psychological, and physiological aspects of chronic pain treatment along with social and cultural factors. Through this method, as well as striving to further the education of providers, higher pain relief outcomes can be achieved, and we can help shape the new outlook on pain medicine in a more realistic, yet helpful, way. By combining multiple treatment methods to best suit the needs of each individual patient we can achieve better and more cost-effective healthcare.

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Appendix A

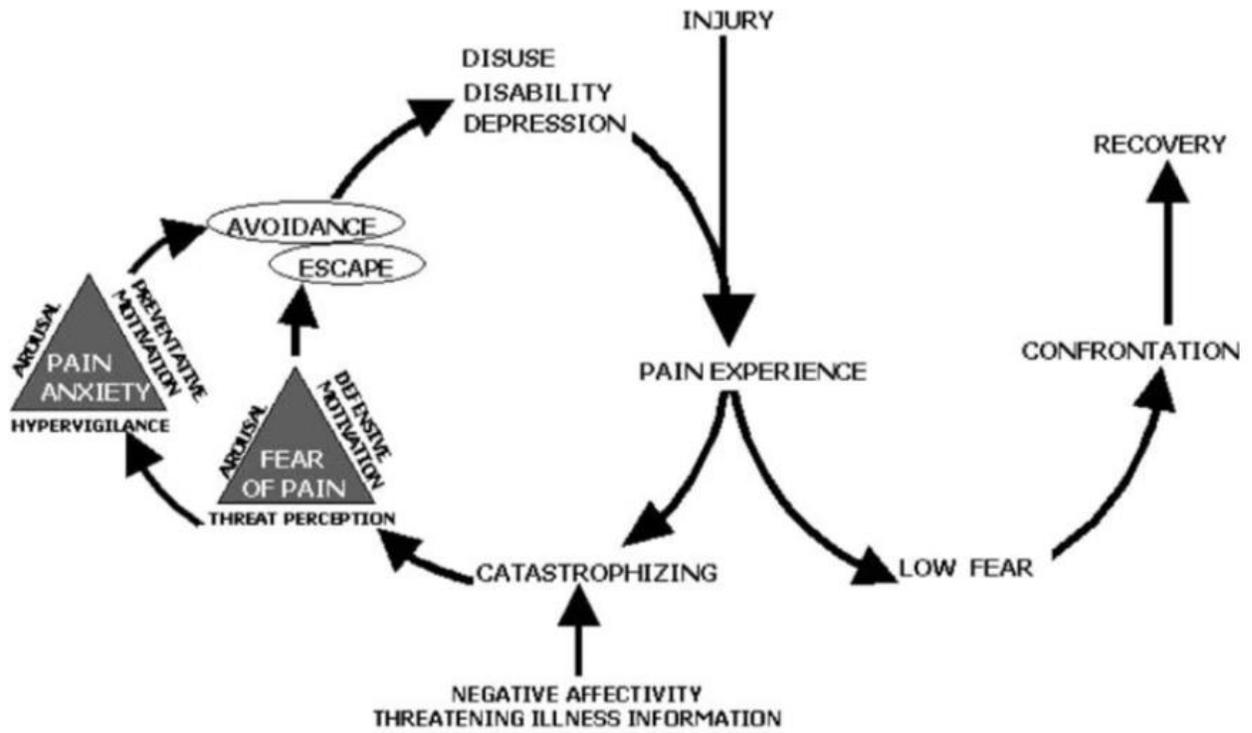


Figure 1. The fear-avoidance model of chronic pain as explained in Leeuw et al., 2007.

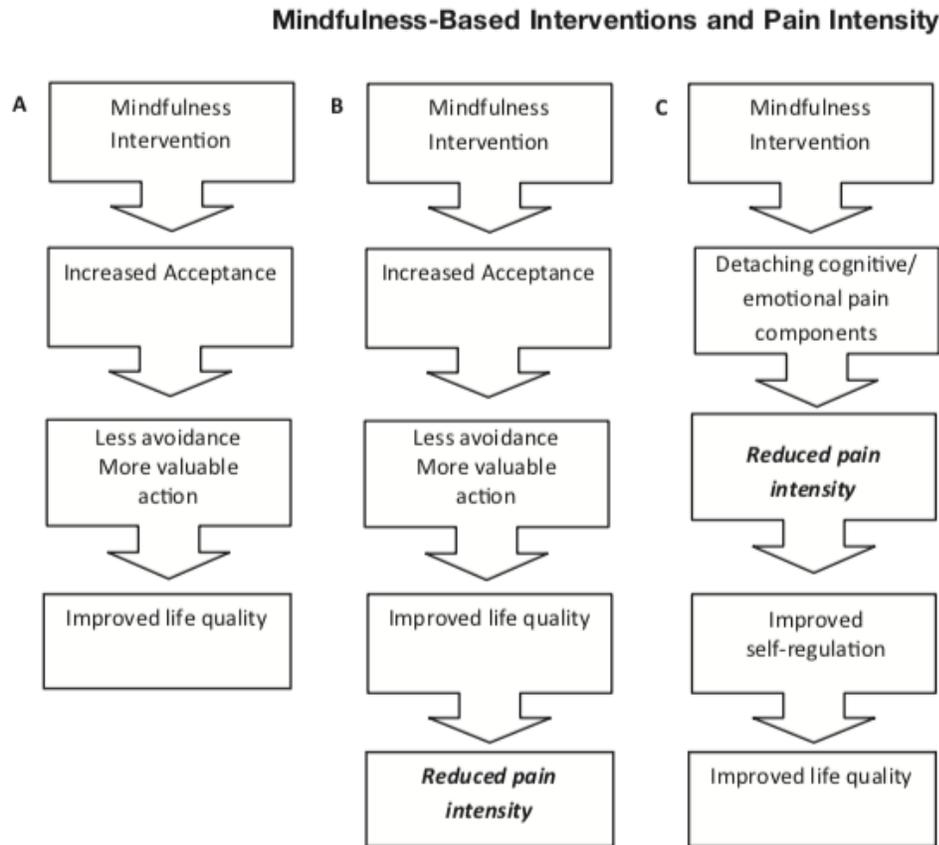


Figure 2. Explanation of possible mechanisms of change as seen in mindfulness-based interventions. Part A represents the traditional view, in which improved life quality is achieved by increasing acceptance without the need of changing pain perception. Part B represents the way treatment increases acceptance, leading to behavioral change, which then leads to improved quality of life and reduced pain intensity. Part C represents how improved quality of life can be achieved through the influence of how pain is perceived which mediated a change in self-regulation, leading to improved quality of life.