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# The Economic Impact: Optimum Timeline from Behavioral Therapies to Surgical Therapies in Response to Pain

Short title: Economic Impact of Pain Therapies

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## ***Abstract***

The purpose of this article is to investigate the characteristic influences and costs associated with pain management therapies designed for treating patients in chronic pain in order to determine the optimum order for trying pain management therapies. Twenty-nine approaches to pain management (including folk, integrative, standard, and surgical) were identified. After a brief description of each of the pain management methods, each was rank ordered on five characteristics: level of invasiveness, duration of expected relief, potential life impact, risk of side effects, and cost. Costs were estimated from several aspects: the patient costs, the insurance costs, and/or the government costs. A pain management approach index was calculated based upon the rank orders, and a prioritized list of approaches was developed. Having this list should help physicians and patients make better, more informed decisions regarding pain management approaches for acute or chronic pain. Simply reviewing the list may help physicians discuss less-intrusive, lower-cost treatments with fewer side effects than the typical drugs or surgery which tend to have more side effects and are more costly. Use of such a list may become part of the arsenal of tools utilized by physicians to combat the current opioid epidemic.

*Keywords: healthcare costs; economic impact of treatment; pain management; behavioral therapy; opioid addiction prevention*

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### ***Historical Perspective on Models of Pain***

Modern models of pain mechanisms are built upon earlier models such as Melzack and Wall's Gate Control Theory which became popular in 1965 [1]. Later Melzack refined the theory and described the Neuromatrix Model of Pain [2]. Earlier in the century, the medical community recognized only direct modality-pain signals. In other words, physicians did not consider sensory perception of pain. They also did not recognize the adjustment of the nervous system to stimuli that previously did not cause pain but would begin to cause pain inexplicably. Doctors would simply ignore pain for which they could not find a cause, as if it did not exist. Rather than recognize only pain with a specific ideology, Melzack explained how and why pain can cause itself, and become the modality. Melzack recognized the important relationship between pain and stress. He was among the first to realize the powerful therapies available to decrease tension (relaxation), and the variety of ways to decrease pain intensity and break the pain-stress feedback loop which underlies so much chronic pain. He used the term neuromatrix to describe any particular individual's experience of pain.

More and more, the medical community is recognizing that neuroplasticity, with its ability to change the structure and function of the nervous system itself, may be essential to decrease intractable chronic pain. The brain chemistry requires changes to alter an individual's sensitization and modulation of pain, particularly pain that no longer has an objective pain stimuli.

Another useful paradigm in conceptualizing and understanding pain issues is the Biopsychosocial Model [3]). This model uses a multidimensional framework to describe the relationship between physical, psychological, and social factors that influence the type, severity, and presentation of pain. Many factors must be considered when assessing and treating pain; history, emotions, family status, and numerous other variables.

Unfortunately, these models and theories of pain are relatively new, and are sometimes unknown by currently practicing physicians. There is sometimes a tendency among primary care physicians to dismiss complaints of pain, especially when no physical pathology can be identified. This has begun to change. One influence that has spurred more research and development into this area is returning veterans who have a very high incidence of chronic idiopathic pain [4].

While not essential to understanding the economic analysis of pain treatments, it is helpful to understand the myriad of influences in managing pain when making decisions about treatments.

### ***Economics Place in Pain Management***

The economics of pain management is not a small issue. The Institute of Medicine estimates that pain causes a burden to approximately 100 million U.S. adults, at a cost of at least \$560-635 billion annually (not counting people who are institutionalized, or the indirect cost of pain such as loss of productivity). Individuals who are beset by pain know the cost is more than simply dollars; the cost in quality of life is immeasurable [5].

## **Approaches to Pain Management**

Beyond the initial diagnosis and treatment (if possible) of any underlying conditions that cause the pain, either acute or chronic, there are several different approaches to pain management. Each approach carries with it certain costs, advantages, and disadvantages. Each approach can be placed on a line of continuum from the least invasive to the most invasive, and from short term or temporary to long term or ongoing impact on the future life of the patient. Additionally, each can be placed on a line of continuum of outcomes from short term (hours) to long term (years) relief.

Typically, pain treatments are less than 50% effective. Pain relief, especially chronic pain relief, is often a matter of multiple treatments rather than a single treatment. The psycho-social aspect of pain is a complicating factor. Rather than a simple diagnose-and-treat situation, pain relief often requires the more complicated multidisciplinary team approach. Pain management specialists are adept at figuring out what combination of treatments each patient requires based upon the type of pain, duration of pain, psycho-social impact and attenuation the neuromatrix of pain.

It is precisely because pain management requires a combination of a multitude of treatments to be fully effective that economic factors are so important. It may be that two treatments are equally effective at minimizing pain, but one treatment is very expensive and another is inexpensive. When there are only two choices, it is very easy to see the options. But when there are dozens of choices, and multiple treatments necessary to solve the problem, the decision is not quite so simple. If we take into account all the different approaches to pain relief, and we optimize them based upon factors such as cost, risk, side effects, impact to life, invasiveness, and typical pain relief duration, then we can help a patient establish, for themselves, the optimal order in which to try different pain management approaches. Obviously, if the less expensive, less invasive, less risky treatments provide enough of a solution, there would be no need for the more expensive, more invasive, higher impact, more risky treatments.

For purposes of this paper, using a combination of the literature and professional experience, the following pain management methods have been identified:

1. Benign Neglect
2. Cold/Heat
3. Over The Counter Analgesics
4. Topical Analgesic
5. Folk Remedies
6. Prescription NSAIDS
7. Prescription Opioids
8. Muscle Relaxants
9. Adjuvant Analgesics
10. Massage Therapy
11. Physical/Behavioral Therapy (Exercise, both directed and general)
12. Nutrition Therapy
13. Biofeedback/Meditation Therapy
14. Chiropractic Adjustments
15. Mind/Body Physical Practices (Qigong, Tai chi, Yoga, Pilates)
16. CBT/ACT Therapies
17. TENS nerve stimulator

18. Acupuncture, Acupressure
19. Epidural Steroid Injection
20. Trigger Point Botox injection
21. Anesthetic Injection: Celiac Plexus Block or Stellate Ganglion Block
22. Radiofrequency Ablation
23. Spinal Cord Stimulation
24. Intrathecal Pump
25. Deep Brain Stimulation
26. Motor Cortex Stimulation
27. Surgical ligament release, removal, or adjustment
28. Surgical Release and/or relocation of nerve
29. Surgical Fusion

## **Pain Management Approach Descriptions**

In the list of pain management approaches, practices that are already included in typical standards of care and covered by health insurance are briefly described, while newer integrative health practices that are not yet part of reimbursable pain management approaches will have some citations establishing evidence of their efficacy. Finally, surgical interventions are listed, but not discussed in detail (as that would be beyond the scope of the paper).

### **Benign Neglect**

This is not actually a pain relief approach at all, because this is the option chosen when the patient is told to *wait it out* or *just live with it* or *nothing can be done*. If the pain is minor, has an obvious pathology (like a cut finger) which is expected to resolve within a very short time, then typically this would be the right choice. Unfortunately for many patients in chronic pain, especially neuropathic pain, this is the answer they receive from their physicians regardless of the circumstances, especially if their physicians are not up-to-date on the latest research regarding models of pain. For example, there are still many in the medical community who don't consider fibromyalgia a "real" disease, and consider sufferers of that malady as having a mental health problem rather than a physical problem. Additionally, recent problems with opioid abuse results in many physicians looking at complaints of pain with a critical eye. It is a reality that they must separate opioid seeking behavior based in addiction from pain relief seeking behavior in general; something that is not easy to do since it is difficult to establish, without a lot of sophisticated diagnostics, whether pain is actually felt or just reported to be felt. This paper, however, may provide these physicians with options for their patients that they may not have considered before thereby eliminating cases where no treatment can be offered.

### **Cold/Heat**

The typical advice for minor sprains and bruises is the RICE (rest, ice, compression, and elevation) approach. Recent research has found evidence that the rest and compression part of that equation may be counter-productive [6], but the ice part has been validated. Additionally, hot pads soothes sore muscle ailments. Easy to accomplish and relatively helpful, this approach is often one of the first to use for nociceptive pain. Unfortunately, it appears not to be as useful (and sometimes harmful) for neuropathic pain.

### **Over The Counter Analgesics**

One of the typical initial pain relief approaches is to take acetaminophen or a non-steroidal such as aspirin (acetylsalicylic acid), ibuprofen, naproxen. Many of these are available over the counter, without a prescription, though a prescription may be necessary to get stronger dose. Easy to get, easy to take, with some small risk of gastrointestinal issues or reduced kidney function if taken repeatedly over a long period of time.

### **Topical Analgesic**

Topical analgesics are applied to the skin and have a numbing effect. Typical treatments are capsaicin, lidocaine, diclofenac, menthol-methyl salicylate. Side effects are nausea, skin sensitivity to burning or cold. Many are available over-the-counter although, like their pill counterparts, may also be available in prescription strength through a medical doctor.

### **Folk Remedies**

Although not usually part of the medical standard of care, folk remedies are utilized by millions of people with often good results. There are many; turmeric, tart cherry juice, pectin, arnica, aquamin (Lithothamnion red algae), fish oil, nine gin-soaked raisins, etc. Though they often have not been rigorously studied with randomized controlled research (possibly due to a lack of monetary reward for such an endeavor rather than a lack of efficacy), there are many people who anecdotally swear by these types of therapies, especially for minor chronic pain such as arthritis. The lack of side effects is also one of the reasons for their popularity.

### **Prescription NSAIDs**

In addition to aspirin, ibuprofen, and other over-the-counter NSAIDs available in prescription strength, there are several medications: etodolac, meloxicam, piroxicam, or salsalate. Additionally, there are some medications that are especially effective on headaches: propranolol, butalbital, rizatriptan, sumatriptan, zolmitriptan. Side effects include gastrointestinal and renal failure as well as rebound headaches. A rebound headache is one that is caused by the medication taken to eliminate headaches.

### **Prescription Opioids**

There are many opioids available by prescription: alfentanil, alphaprodine, beta-casomorphins, buprenorphine, carfentanil, codeine, deltorphin, dextromethorphan, dezocine, dihydrocodeine, dihydromorphine, ethylketocyclazocine, ethylmorphine, etorphine, fentanyl, heroin, hydrocodone, hydromorphone, ketobemidone, levorphanol, lofentanil, meperidine, meptazinol, methadone, methadyl acetate, morphine, nalbuphine, opium, oxycodone, oxymorphone, pentazocine, phenazocine, phenoperidine, piritramide, promedol, propoxyphene, remifentanil, sufentanil, tilidine, tapentadol. Tramadol is also an opioid, but has dual action; it releases norepinephrine and serotonin like an antidepressant.

One of the major issues with prescription opioids is physical dependence which can lead to addiction. While a person can become physically dependent within a very short time (a few days or weeks) necessitating withdrawal symptoms when the drug is no longer required, addiction is one step further, when a person behaves in a way that is ultimately

damaging in order to maintain the drug, exhibiting an uncontrollable compulsion and loss of control.

Addiction is not a minor issue to the patient or to society at large. The cost to society of opioid abuse is estimated to be around 56 billion dollars [7]. Overdoses are escalating at a phenomenal rate. The overdose death rate quadrupled between 1999 and 2006. Admission rates for substance use disorder treatment grew six-fold between 1999 and 2009. Four in five new heroin users started out by using prescription opioids. Accidental (or purposeful) overdose is not insignificant. Overdose deaths more than quadrupled from 2000 to 2013. In a survey of addicts under treatment, 94% of respondents said they chose to use heroin because prescription opioids were too difficult to obtain [8-10].

Another major side effect of opioids is depression, caused by the disruption of the normal endogenous opiate release and mood regulating neurotransmitters such as dopamine, gamma amino butyric acid (GABA), norepinephrine, and serotonin. Opioids interfere with sympathetic up-regulation. The longer a patient takes the opioid, or the larger the dose, the higher the chance of developing major life-impacting depression that can further interfere with recovery[11].

Even more importantly, doctors are now finding out that the escalating tolerance for opioids is not just the body adjusting to the drugs, it is an actual increase in the amount of pain felt by the patient, a condition doctors are now calling hyperalgesia [12]. Like rebound headaches, the medication actually causes more of the problem for which it is taken to ameliorate.

There are also immediate minor physical side effects from opioids including constipation, nausea, drowsiness, dizziness, vomiting. One might ask the question; with so many negatives, why do physicians prescribe opioids? For one, patients expect it. They would feel the doctor is not doing his or her job if they don't prescribe the strongest pain relievers possible after surgery or injury, and are often unaware of the disadvantages. Opioid pain medication is a huge business for the pharmaceutical companies; opioids accounted for 24 billion dollars of the trillion dollar pharmaceutical industry. For another, many of the negatives are just recently coming to light. Without the long term, high volume data available recently, it would be difficult to see how prescribing opioids could have a negative long term effect, and literally cause major damage to patient's future lives. Only recently have legislatures started to attempt restricting the standards of care which encouraged opioid prescriptions rather than seeking out alternatives.

### **Muscle Relaxants**

Muscle relaxants include cyclobenzaprine, tizanidine, baclofen and methocarbamol. Side effects experienced might be sedation, dizziness, headache, nausea, irritability, nervousness, and addiction.

### **Adjuvant Analgesics**

Adjuvant analgesics are off label use of prescription medications. Anti-depressive and anti-convulsive medications have been found to work effectively as pain killers, especially when the pain is neuropathic. Medications include carbamazepine, amitriptyline, duloxetine, venlafaxine, nortriptyline, gabapentin, pregabalin, topiramate, and lamotrigine. Side effects include nausea, vomiting, insomnia, decreased sex drive, constipation, dizziness, fatigue, weight gain, and drowsiness.

### **Massage Therapy**

Deep therapeutic massage in the hands of a therapeutic massage professional has been shown to relieve pain with no side effects [13-17]. Not just applicable to massage of the specific area in pain, massage therapy can promote the relaxation response which changes the brain chemistry necessary for pain relief.

### **Physical/Behavioral Therapy**

Physical/Behavioral Therapy is physical therapy, already a standard of care, plus other supplementary activities. For example, movement education or occupational therapy (which educates people how to adjust their movements, align their joints, straighten their back, lift with their legs, etc.) can be very helpful in preventing painful damage to muscles, ligaments, and joints [18-20]. One of the most effective pain therapies is regular moderate exercise of any type; walking, swimming, biking, hiking, etc. [21-28]

### **Nutrition Therapy**

Many integrative health practitioners focus on the impact of one's diet on overall health. Changing the diet can impact not only future health issues (well known), but also pain tolerance, though not studied as rigorously (again, perhaps due to the lack of financial rewards for doing so). Nonetheless, there are enough specific dietary components being studied to warrant more investigation into the notion that an anti-inflammatory, anti-oxidant diet rich in fresh fruits and vegetables can impact pain levels in a positive way [29-32].

### **Biofeedback/Meditation Therapy**

Biofeedback therapy involves using technology to teach patients how to empty their minds and relax their muscles which causes bio-physical changes that provide pain relief. In biofeedback, the patient gets hooked up to a system which visually represents their muscle tension and pain levels in some way. They the patient purposefully relaxes until the visual representation shows lowered tension and pain levels.

Meditation provides the same lesson, using the same methods, sans technology. In both cases, recent research abounds on the potential for biofeedback/meditation therapy to assist people in their quest for pain relief [33-36]. Meditation does not appear to have any side effects; indeed, many find the regular practice of meditation improves the quality of their lives in other ways, beyond the benefits of pain relief.

### **Chiropractic Adjustments**

Chiropractic services has long provided pain relief through adjusting the spinal column to eliminate alignment issues which allow the body's systems to function more effectively. The side effects are minimal, including localized soreness, headache, and fatigue.

### **Mind/Body Physical Practices**

Tai chi, Qigong, Yoga, and Pilates are all physical exercises with a mind-body component, usually meaning that the thought process and breathing guidance is included as part of the exercise. Within the last few years, the amount of research has demonstrated a preponderance of evidence that these practices are useful as a pain management approach, especially when dealing with chronic pain [22, 37-43].

While the exercises are usually gentle and easy, the effect of doing them regularly can be a powerful influence on the neurotransmitters and sympathetic nervous system in the body regulating pain. Again, there appear to be no negative side effects.

### **CBT/ACT Therapies**

One of the most effective therapies for pain management appears to be Cognitive Behavioral Therapy (CBT), followed by Acceptance and Commitment Therapy (ACT)[44, 45]. Because of the strong influence of attitude and behavior on pain receptors through the mediation of neurotransmitters, being able to adjust one's behavior can impact pain levels. By thinking through the issues, making a plan and not giving up just because one is in pain, pain levels actually decrease.

### **TENS nerve stimulator**

Transcutaneous electrical nerve stimulation (TENS) has become quite popular in physical therapy, and has a strong history of helping people to relieve pain. Side effects include localized soreness, muscle twitching, and skin irritation.

### **Acupuncture, Acupressure**

Though practices for thousands of years in eastern countries, acupuncture has only recently been accepted by modern western medicine. The art of placing very thin needles at certain points of the body is taught in Traditional Chinese Medicine (TCM). The concept is that illness is caused by imbalance from either the stoppage or overflow of chi. Some believe that acupuncture works by calibrating the central nervous system's network of connections and resetting the sympathetic nervous system [46].

### **Epidural Steroid Injection**

An Epidural Steroid Injection works by injecting steroids directly into the spinal column. Epidural side effects are localized pain at the injection site, headache, facial flushing, anxiety, sleeplessness, fever, high blood sugar, and decreased immunity [47].

### **Trigger Point Injection**

Trigger points are highly sensitive and painful knots within the muscles. Several chronic pain maladies are characterized by these points even when the pain is actually felt in other parts of the body. Injecting trigger points with corticosteroid, saline, or botulinum toxin type A can decrease pain. Side effects include nerve damage, spinal cord inflammation, pain at injection site, infection, and excessive bleeding.

### **Surgical Treatments for Pain**

The remaining nine treatments for pain are all surgical in nature, requiring the consult and services of a skilled medical surgeon. Surgical treatments of pain are generally treatments of last resort; only being tried if intractable pain continues despite previous attempts to mitigate it.

Many surgical treatments have similar side effects and risks, which are very high compared to many of the other approaches (one of the reasons surgery is the last resort). Common side effects include localized pain, swelling and bruising, infection, bleeding, allergic reaction, weakness, numbness, clumsiness, paralysis. Some approaches have more

specific side effects. For example, side effects for intrathecal drug pumps include those involving the surgery itself such as minimal activity allowed for several weeks after surgery, infection, and bleeding. Additionally, patients suffer from side effects involving the opioid medication pumped into the spine, such as respiratory depression, twitching, muscle spasm, urinary retention, constipation, nausea, vomiting, dizziness, anxiety, depression, hyperalgesia, and edema. Furthermore, the intrathecal pump needs to have its battery replaced every 5 – 7 years, which requires more surgery. Deep brain stimulation also has specific side effects; apathy, hallucinations, hyper sexuality, cognitive dysfunction, depression, euphoria, personality changes, bleeding, swelling, disorientation, sleepiness, and allergic reaction.

Many surgical approaches are attempts to permanently prevent the recurrence of chronic pain by physically removing bones, ligaments, or nerves which appear to be causing the pain. Others are simply finding better ways of delivering medication, such as the Intrathecal Pump, the Anesthetic Injections. Some have many different sub-surgical types, such as Cordotomy, Dorsal Root Entry, Sympathectomy, Myelotomy, Mesencephalotomy, Cingulotomy, which are all Ablation methods. Many are attempts to reset the brain's reaction to pain, or to damage the nerves that pass on the pain signal. Like many other pain management methods, success levels are varied. Sometimes the treatment has no effect at all, other times it is completely effective for a short time. In a minority of cases (though important to the patients) there is complete and permanent resolution of pain.

It goes beyond the scope of this paper (besides being beyond the expertise of the author) to discuss the individual surgical methods or to compare them. Based upon a reading of the literature, however, the following approaches are being included in the list:

- Anesthetic Injection: Celiac Plexus Block or Stellate Ganglion Block
- Radiofrequency Ablation
- Spinal Cord Stimulation
- Intrathecal Pump
- Deep Brain Stimulation
- Motor Cortex Stimulation
- Surgical ligament release, removal, or adjustment
- Surgical Release and/or relocation of nerve
- Surgical Fusion

### **Approaches to Economic Analysis of Healthcare**

Most healthcare cost research falls into two grand categories: 1) *Cost of Illness* and 2) *Comparative Effectiveness*. If a Cost of Illness study is done on pain management treatments, it would estimate the cost of chronic or acute pain for three different entities: 1) individuals, 2) healthcare systems, and 3) society, as outlined in Larg's 2011, *Cost-of-Illness Studies: A Guide to Critical Evaluation*, published in the Pharmacoeconomics journal [48]. Cost-of-illness studies often include costs that are paid by the patient, or the insurance company, or the government, or the provider themselves (if they are not reimbursed through insurance or government program).

In a Cost of Illness study, both direct and indirect costs are considered. A direct cost is the actual amount paid directly for diagnosis and treatment. An indirect cost could be travel to the treatment. An indirect cost could also be the economic cost to society due to

lost productivity – which impacts chronic pain patients quite a bit. Costs may also be intangible, as in the case of pain and suffering or the reduction in quality of life [49].

Which costs are used in the calculation can impact the results. One researcher compared the estimates of a cost effectiveness results of two drugs using both the wholesale acquisition cost and the average wholesale price. The difference in price caused the cost effectiveness ratio to swing from .44 (cost effective) to 1.73 (not cost effective), which would completely change the recommendation for treatment. The results were further complicated by the fact that there is not only a wholesale cost, but also a charged cost, an allowed cost, and a paid cost. These different costs are often controlled by different parties [50]. Additionally, some researchers note that we have to consider the social cost (the deadweight loss) of a resource, which is different than the price. For example, the social cost of a new pain relief drug might be one-third the market price to insurance companies, and one-half the market price when paid for by one of the government healthcare options [51].

There have been several attempts to quantify in dollars the nebulous characteristic of "quality of life". This is important because quality of life means quite a bit to the patients who suffer with chronic pain [52]. The other type of economic costs analysis are *comparative effectiveness* studies, which focus on comparing different pain management treatments - not just for costs, but also for quality and effectiveness (though more often just direct costs since, ostensibly, indirect costs and quality of life are not impacted by different treatments). For example, when the costs of three different treatments for high blood pressure are evaluated [53].

There are several cost benefit analysis methods used in both Cost of Illness studies and Comparative Effectiveness studies. These methods include *Cost Benefit Analysis*, *Budget Impact Analysis*, *Cost Effective Analysis*, *Cost Utility Analysis*, *Cost Minimization Analysis*, and *Cost Consequence Analysis* [54]. The use of these different methods can be seen in a study conducted on college students in evaluating a cost cessation program [55]. Each will be briefly explained.

*Cost Benefit Analysis* is overly simplistic and not really appropriate for healthcare costs, though used often anyway [56]. *Budget Impact Analysis* assesses the financial impact of the introduction of a new treatment. There are several different types: *deterministic calculation*, *Markov models*, and *discrete-event simulations*[57]. *Cost Effective Analysis* uses something else (other than money) as an outcome. These alternative measures takes into account both quantity and quality of life. Examples include *number of events* (NE), *simple life-years* (LY), *Quality Adjusted Life Year* (QALY), *Disability Adjusted Life Years* (DALY), *Prevalent Years of Health Life Lost to Disability* (PYLD) and *Willingness to Pay* (WTP). The last four of these are a bit more complex, but a more detailed explanation is beyond the scope of this paper [58].

### ***Difficulties in Conducting Cost Analysis on Pain Management Treatments***

Healthcare Cost Analysis on Pain Management Treatments have several issues that make it difficult to conduct. Although newer methods try to make adjustments, most health cost analysis research focuses on the quantity, not quality, of life. Pain management often doesn't impact the length of someone's life – with one noted exception; suicide or accidental overdose. According to the America Society of Addiction Medicine, drug overdose is the leading cause of accidental death in the US, with 47,055 lethal drug

overdoses in 2014. Of those deaths, 18,893 were related to prescription pain relievers [9]. In the case where the patient cuts short their own life through suicide or accidental overdose because of the pain, dealing with chronic unending-pain has a strong influence on life expectancy [59]. Nonetheless, the impact of treatments on the quality of life for pain patients can be enormously important, more-so than the quantity of life.

Quality of Life, however, is very difficult to measure. One study provided a persuasive argument that scientific comparisons of health decisions have no validity. After reviewing 37 studies to treat major depressive disorder, for example, they concluded that there was no way to tell the optimum treatment from the studies [60].

There are several studies that demonstrate where people are able to reduce their own risk of disease or injury. In chronic pain cases, often a major cause of the condition is their own behavior (which applies almost all chronic diseases). Studies based on lifestyle changes had a very low median incremental cost effectiveness ratio. A low ratio means that *lifestyle changes* performed well and were more cost effective when compared to other treatments [61].

Another problem with healthcare research is that behavioral intervention studies often do not include partial (though beneficial) pain relief. If researchers incorporated a decrease in some pain when reporting cost effectiveness of a treatment, their results might be different [62].

It is well known that looking at costs does not provide enough information for decision-making support [63]. It is also well-known that even when costs are held constant, there is a great deal of variation in the quality of treatments [64]. Yet, there are few other unbiased and quantitative factors upon which to base a decision, so looking at economics of pain management therapies, in the context of a variety of characteristics of each therapy, is an important step in the process.

This discussion of various cost analysis methods demonstrates the wide scope of methods. The methods used in this paper are much more simplistic, but take into account the issues raised regarding any cost analysis of healthcare. To avoid many of these issues, rank orders were utilized to analyze the factors, including costs.

### ***Rank Ordering of Pain Management Approaches***

The pain management approaches can be rank ordered on many characteristics such as cost, risk, side effects, impact to life, invasiveness, and typical pain relief duration. These factors influence the optimal order in which a patient may try different pain management approaches. Some pain management approaches are only relevant to certain types of pain. For example, a spinal fusion is only applicable to back pain. Many approaches, however, are applicable whether the pain is nociceptive, neuropathic, or headache (which doesn't fit neatly into either). A patient can be encouraged to try multiple treatments for a minimal (several months) of time before giving up on the treatment as not applicable to their particular pain. Research has shown that a multidisciplinary approach to pain management is best, as no single method is usually sufficient to relieve pain and return the patient back to a productive, high-quality life.

The first rank ordering of the methods will be amount of invasiveness. Obviously surgical methods will be more invasive than non-surgical methods. The results are in the first table (Table 1).

**Table 1. Rank order of Pain Management Approaches by Invasiveness**

Invasive Rank	Category	Approach	Area of Body in Pain
1	None	Benign Neglect	Any
2	Folk	Cold/Heat	Any
3	Folk	Over The Counter Analgesics	Any
4	Folk	Topical Analgesic	Any
5	Folk	Folk Remedies	Any
6	Standard	Prescription NSAIDS	Any
7	Standard	Prescription Opioids	Any
8	Standard	Muscle Relaxants	back, neck, tension headaches, fibromyalgia.
9	Standard	Adjuvant Analgesics	Any
10	Integrative	Massage Therapy	back, neck, tension headaches, appendages
11	Physical	Physical/Behavioral Therapy	back, neck, tension headaches, appendages
12	Integrative	Nutrition Therapy	Any
13	Integrative	Biofeedback/Meditation Therapy	Any
14	Integrative	Chiropractic Adjustments	back, neck, tension headaches
15	Integrative	Mind/Body Physical Practices	Any
16	Integrative	CBT/ACT Therapies	Any
17	Physical	TENS nerve stimulator	back, neck, appendages
18	Integrative	Acupuncture, Acupressure	Any
19	Standard	Epidural Steroid Injection	neck, arm, back, leg
20	Standard	Trigger Point Botox injection	back, neck, appendages, tension headaches, myofascial pain fibromyalgia
21	Surgical	Anesthetic Injection: Celiac Plexus Block or Stellate Ganglion Block	abdominal pain or neck
22	Surgical	Radiofrequency Ablation	neck, arm, back, leg
23	Surgical	Spinal Cord Stimulation	back and limbs, failed back syndrome, reflex sympathetic dystrophy, arachnoiditis, and peripheral neuropathy
24	Surgical	Intrathecal Pump	back and limbs, failed back syndrome, reflex sympathetic dystrophy, arachnoiditis, and peripheral neuropathy
25	Surgical	Deep Brain Stimulation	Cancer pain, phantom limb pain
26	Surgical	Motor Cortex Stimulation	Post stroke pain, trigeminal neuralgia
27	Surgical	Surgical ligament release, removal, or adjustment	Carpel Tunnel, knee surgery
28	Surgical	Surgical Release and/or relocation of nerve	carpal tunnel, cubital tunnel, tarsal tunnel, peroneal knee, thoracic outlet
29	Surgical	Surgical Fusion	Back

The pain management approaches can also be rank ordered by impact on lifestyle and amount of typical pain relief. This can be found in Table 2.

**Table 2. Rank Order Pain Management Approaches by Impact and Duration**

Approach	Impact on lifestyle	Typical Pain Relief
Benign Neglect	1. No Impact	Hrs.
Cold/Heat	2. Minor temporary impact	Hrs.
Over The Counter Analgesics	2. Minor temporary impact	Hrs.
Topical Analgesic	2. Minor temporary impact	Hrs.
Folk Remedies	2. Minor temporary impact	Days
Prescription NSAIDS	2. Minor temporary impact	Hrs.
Muscle Relaxants	2. Minor temporary impact	Hrs.
Adjuvant Analgesics	2. Minor temporary impact	Hrs.
Massage Therapy	2. Minor temporary impact	Days
Chiropractic Adjustments	2. Minor temporary impact	Days
TENS nerve stimulator	2. Minor temporary impact	Days
Acupuncture, Acupressure	2. Minor temporary impact	Days

Approach	Impact on lifestyle	Typical Pain Relief
Epidural Steroid Injection	2. Minor temporary impact	Weeks
Trigger Point Botox injection	2. Minor temporary impact	Weeks
Prescription Opioids	3. Major ongoing negative impact	Hrs.
Spinal Cord Stimulation	3. Major ongoing negative impact	Months
Intrathecal Pump	3. Major ongoing negative impact	Ongoing
Biofeedback/Meditation Therapy	3. Major ongoing positive impact	Days
Mind/Body Physical Practices	3. Major ongoing positive impact	Ongoing
CBT/ACT Therapies	3. Major ongoing positive impact	Ongoing
Physical/Behavioral Therapy	3. Major temporary positive impact	Ongoing
Nutrition Therapy	4. Major ongoing positive impact	Ongoing
Anesthetic Injection: Celiac Plexus Block or Stellate Ganglion Block	5. Major One-time impact	Months
Radiofrequency Ablation	5. Major One-time impact	Months
Deep Brain Stimulation	5. Major One-time impact	Months
Motor Cortex Stimulation	5. Major One-time impact	Months
Surgical ligament release, removal, or adjustment	5. Major One-time impact	Months
Surgical Release and/or relocation of nerve	5. Major One-time impact	Years
Surgical Fusion	5. Major One-time impact	Years

The final rank order will be by cost of procedure (Table 3). Given the discussion previously on the difficulties of analyzing economics, and the myriad of choices regarding the items, it was decided to look up the codes for each procedure in a consumer-lookup site (<http://fairhealthconsumer.org/>). When the procedure was not available, a fair sample (3-5) of instances of the costs were searched on the World Wide Web and utilized. When possible, the cost to the patient, the cost to the insurance company, and the cost to Medicare were recorded. Based upon these myriad of costs, an assessment was made that enabled the procedures to be rank ordered based upon their 5 year cost. Because some of the costs are ongoing (such as massage therapy, mind-body therapies, etc.) and dose-specific, the typical number of times the therapy would be paid for was utilized to rank order. For example, a Pilates, Yoga, or Tai chi class would typically be held 2 times per week, whereas a massage was more typically done 1 time per week. Surgery would typically be counted only once, except in the cases where a battery would need to be replaced; the cost would include one additional surgery for that purpose.

**Table 3. Rank Order by Five Year Cost and Impact of Potential Side Effects**

Approach	Rank Order of Costs (5 year)	Impact of Potential Side Effects
Benign Neglect	1	None
Cold/Heat	2	None
Folk Remedies	3	Small
Over The Counter Analgesics	4	Small
Topical Analgesic	5	Small
Trigger Point Botox injection	6	Medium
Epidural Steroid Injection	7	Medium
Biofeedback/Meditation Therapy	8	Positive
Nutrition Therapy	9	Positive
Prescription NSAIDS	10	Medium
Muscle Relaxants	11	Medium
Spinal Cord Stimulation	12	High
Anesthetic Injection: Celiac Plexus Block or Stellate Ganglion Block	13	High
Radiofrequency Ablation	14	High
Adjuvant Analgesics	15	Medium
Intrathecal Pump	16	High
CBT/ACT Therapies	17	Positive
Surgical ligament release, removal, or adjustment	18	Medium
Motor Cortex Stimulation	19	High
Surgical Release and/or relocation of nerve	20	High
Chiropractic Adjustments	21	Medium
Mind/Body Physical Practices	22	Positive
Prescription Opioids	23	High

Approach	Rank Order of Costs (5 year)	Impact of Potential Side Effects
Deep Brain Stimulation	24	High
Physical/Behavioral Therapy	25	Positive
Acupuncture, Acupressure	26	Small
Surgical Fusion	27	High
Massage Therapy	28	Positive
TENS nerve stimulator	29	Small

In addition to the rank order of the cost, whether or not there is potential for negative side effects must be taken into account. For each approach listed, in addition to the rank order of the cost, the assessment for potential negative side effects has been listed (Table 3). Small, Medium, and High are relative assessments for negative, unwanted side effects. When the possibility of negative side effects was non-existent and there was no potential for positive side effects either, the table indicates None. If there was potential for positive side effects, such as the case of Physical/Behavioral Therapy or Cognitive Behavioral Therapy or Mind/Body Practices improving one's overall health, relationships, or quality of life, then the assessment was Positive.

### **Guidelines for Treatment Including Economics**

Due to the severe limitations of this study, it might be considered simply a starting point for further study. One of the difficulties in treatment, however, is the fact that practitioners generally come from only one of the categories. In other words, those who tend to prescribe analgesics are more likely to be primary care physicians, those who perform surgery are likely to be orthopedic or neurological surgeons. Those who work in the integrative medicine world are likely not part of the official health networks at all, and folk medicine or home remedies often have no specific advisor for the patient except for articles in the popular press and websites such as The People's Pharmacy ([www.peoplespharmacy.com](http://www.peoplespharmacy.com)).

The pain management approach to which patients are directed, therefore, is generally a foregone conclusion based upon who they see. If they go to a healer, they will get folk medicine. If they go to a chiropractor they will get an adjustment. If they go to a primary care physician they will get analgesics, and if they go to a surgeon, they will get surgery.

In a perfect world, the primary care physician would take the responsibility to direct the pain management options, and would include low-cost folk medicine and integrative medicine in the continuum of care. Because many primary care physicians are not prepared or trained to do that, pain management specialists have cropped up, at a higher specialty cost, in order to direct the care with multidisciplinary approach. Though they generally include more options such as CBT or physical therapy, even they don't include the whole gamut of options for pain management. Except for those on the cutting edge of pain relief, you will not generally see doctors recommend Tai Chi, Yoga, Pilates, Meditation, or Nutrition Therapy for pain management despite the fact that past anecdotal evidence is strong and now there is growing scientific evidence as well. There is still, however, difficulty in control. Patients could chew willow bark instead of going to the store aspirin, but the dosage would be wildly variable, perhaps causing more problems than it solves. There are no controls, or even guidance, as to mind/body or meditative practices. How often is enough? How long must sessions be? Who is qualified to teach the patient how to do it? These are all valid questions that currently have no standard answer.

From a society perspective, and from the patients perspective, it is beneficial to try folk and integrative medicine before jumping to standard care. Standards of care generally rely upon the patient to try home remedies, exercise, and nutrition before coming to the doctor with a complain of pain, but often patients have not done so, don't understand how powerful simple remedies might be, and are not willing to try something on their own without the blessing of the physician.

Finally, patients themselves must be relied upon to carry out the treatments. Exercise, for example, is generally accepted as being highly effective in a pain management program (as well as many other metabolic maladies). Dosage is even relatively well established scientifically; it is known that 20-60 minutes a day of medium-intensive repetitive exercise such as walking is generally required to make a difference. But other than telling that to the patient, the standard medical practice does not have a system of coaching to help, support, and encourage patients to exercise daily. As a result, it goes unused as part of the pain management program despite its effectiveness.

While this study is only a start, and has many limitations, it does do one thing that most studies do not; it brings together different pain management approaches from many different areas (folk, integrative, standard, and surgical) in order to provide a more complete view of the options. Therefore, despite its limitations, and with the recognition that not all pain management approaches would be appropriate for all sorts of pain, a list was compiled that provides guidelines for the order in which each of the approaches should be utilized (before giving up on it as not effective). These approaches are not mutually exclusive, and it is not a waterfall list. In other words, many approaches (perhaps even dozens) should be tried simultaneously, and those that don't appear effective after a sincere effort and several months of trial should be dropped.

Some of the remedies should only be utilized for a short time (such as analgesics of any sort) due to the fact that side effects increase dramatically as the approach extends in duration. Other remedies, especially the integrative medicine approaches, CBT/ACT and Physical/Behavioral Therapies should be used for at least 6 months before giving up, especially if the pain is not so severe as to require stronger approaches. It should also be kept in mind that some approaches such as opioids or surgery often result in increased pain in the long run. While the patients themselves should be the ultimate deciders on the order and duration of the different approaches, it behooves either the primary care physician or the pain management specialist to present all the approaches, their advantages and their disadvantages, rather than just the standard approaches. The patients should be more fully informed regarding costs and side effects of all the different approaches.

This list takes into account all of the different rank orders; side effects, life impact, typical pain relief, level of invasiveness and, finally, cost. The impact of side effects was given a number value between 1 and 5 equivalent to the potential impact: Positive-1, None-2, Small-3, Medium-4, and High-5. The index was calculated by taking the rank orders of each of the factors and adding them together, times the potential impact of side effects, which provided the final rank order by priority of Pain Management Approach (PMA) seen in Table 4.

**Table 4. Results: Pain Management Approach Priority Index**

Final Ranking	Category	Approach	PMA Priority Index
1	None	Benign Neglect	6
2	Folk	Cold/Heat	10
3	Integrative	Biofeedback/Meditation Therapy	23
4	Folk	Over The Counter Analgesics	24
5	Integrative	Nutrition Therapy	27
6	Folk	Folk Remedies	30
7	Folk	Topical Analgesic	30
8	Integrative	Mind/Body Physical Practices	33
9	Integrative	CBT/ACT Therapies	40
10	Integrative	Massage Therapy	40
11	Physical	Physical/Behavioral Therapy	42
12	Standard	Prescription NSAIDS	68
13	Standard	Muscle Relaxants	80
14	Standard	Adjuvant Analgesics	104
15	Standard	Trigger Point Botox injection	116
16	Standard	Epidural Steroid Injection	116
17	Integrative	Acupuncture, Acupressure	138
18	Physical	TENS nerve stimulator	144
19	Integrative	Chiropractic Adjustments	152
20	Standard	Prescription Opioids	155
21	Surgical	Anesthetic Injection	190
22	Surgical	Surgical ligament release, removal, or adjustment	200
23	Surgical	Spinal Cord Stimulation	205
24	Surgical	Radiofrequency Ablation	205
25	Surgical	Intrathecal Pump	235
26	Surgical	Motor Cortex Stimulation	250
27	Surgical	Deep Brain Stimulation	265
28	Surgical	Surgical Release and/or relocation of nerve	270
29	Surgical	Surgical Fusion	305

### **Limitations**

The limitations of this study are many. The rank orders are subjective. Non-quantitative criteria were used in a way that cannot be objectively validated. The assessments are made in the opinion (expert though it is) of one person, the author. The costs make assumptions about dosage, duration, number based purely on estimated averages in the experience of the author. Even the costs themselves are suspect, as cost information is very hard to get and often has a wide variance, making mean, median, or mode ineffective as estimators. Furthermore, in some cases approaches with vastly different cost structures have been lumped together and an average cost was used.

### **Further Study**

In order to validate this study, the approaches should be split out in even more granularity, with high specific costs associated with different procedures. Furthermore, the types of pain themselves (hand, wrist, lower back, upper back, arm, shoulder, headache, legs, ankle, knees, feet, etc.) should be broken out and assessed separately. Each assessment should be done by more than 2 people, and their assessments should be averaged rather than assessing by one person. To be even more effective, assessments should be done by practitioners in the medical profession, integrative medicine, folk medicine, and people in pain.

## Conclusions

Though subjective in nature, and only a beginning, the information provided in this study can help physicians and patients impact the economics and effectiveness of pain management. Both practitioners and patients benefit from knowledge of all the various approaches to pain management (folk, integrative, standard, and surgical), and from an understanding of the advantages and disadvantages of each on five characteristics: level of invasiveness, duration of expected relief, potential life impact, risk of side effects, and cost. Reviewing this information will help physicians and patients make better decisions with more positive outcomes at lower cost. The analysis shows that more focus and higher priority should be placed on approaches with low incidence of side effects (or positive side effects) such as mind/body practices, biofeedback/meditation, massage therapy, physical/behavioral therapy, and cognitive behavioral therapy. Scientific evidence of the effectiveness of these approaches in pain management is strong and growing. Physicians are urged to become familiar with the whole gamut of pain management therapies, and to direct their patients to try multiple therapies in optimized order before resorting to therapies with more side effects such as opioids and surgery.

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