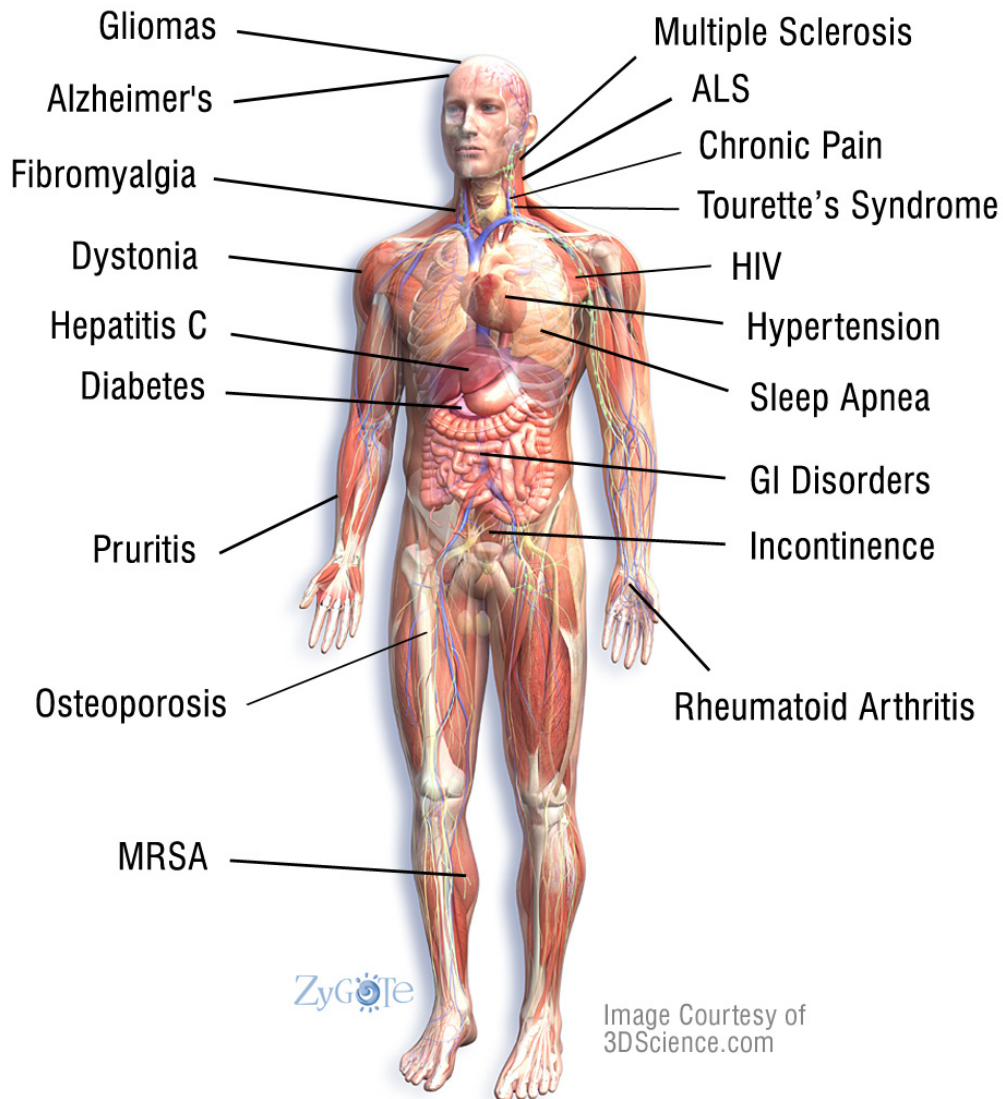


Emerging Clinical Applications for Cannabis and Cannabinoids: A Review of the Recent Scientific Literature, 2000 – 2009



Paul Armentano
Deputy Director
NORML | NORML Foundation
Washington, DC
January 15, 2009
paul@norml.org

Table of Contents

INTRODUCTION	2
FOREWORD.....	6
ALZHEIMER’S DISEASE	10
AMYOTROPIC LATERAL SCLEROSIS	13
CHRONIC PAIN.....	15
DIABETES MELLITUS.....	17
DYSTONIA.....	19
FIBROMYALGIA	21
GASTROINTESTINAL DISORDERS.....	23
GLIOMAS.....	25
HEPATITIS C.....	30
HUMAN IMMUNODEFICIENCY VIRUS	32
HYPERTENSION	35
INCONTINENCE	37
METHICILLIN-RESISTANT STAPHYLOCCUS AUREUS (MRSA)	39
MULTIPLE SCLEROSIS	40
OSTEOPOROSIS.....	43
PRURITIS.....	45
RHEUMATOID ARTHRITIS.....	47
SLEEP APNEA.....	49
TOURETTE’S SYNDROME	50

Introduction

Despite the ongoing political debate regarding the legality of medicinal marijuana, clinical investigations of the therapeutic use of cannabinoids are now more prevalent than at any time in history. A search of the National Library of Medicine's PubMed website quantifies this fact. A keyword search using the terms "cannabis, 1996" (the year California voters became the first of 13 states to allow for the drug's medical use under state law) reveals just 258 scientific journal articles published on the subject during that year. Perform this same search for the year 2008, and one will find over 2,100 published scientific studies.

While much of the renewed interest in cannabinoid therapeutics is a result of the discovery of the endocannabinoid regulatory system, some of this increased attention is also due to the growing body of testimonials from medicinal cannabis patients and their physicians. Nevertheless, despite this influx of anecdotal reports, much of the modern investigation of medicinal cannabis remains limited to preclinical (animal) studies of individual cannabinoids (e.g. THC or cannabidiol) and/or synthetic cannabinoid agonists (e.g., dronabinol or WIN 55,212-2) rather than clinical trial investigations involving whole plant material. Predictably, because of the US government's strong public policy stance against any use of cannabis, the bulk of this modern cannabinoid research is taking place outside the United States.

As clinical research into the therapeutic value of cannabinoids has proliferated – there are now more than 17,000 published papers in the scientific literature analyzing marijuana and its constituents — so too has investigators' understanding of cannabis' remarkable capability to combat disease. Whereas researchers in the 1970s, 80s, and 90s primarily assessed cannabis' ability to temporarily alleviate various disease symptoms — such as the nausea associated with cancer chemotherapy — scientists today are exploring the potential role of cannabinoids to modify disease.

Of particular interest, scientists are investigating cannabinoids' capacity to moderate autoimmune disorders such as multiple sclerosis, rheumatoid arthritis, and inflammatory bowel disease, as well as their role in the treatment of neurological disorders such as Alzheimer's disease and amyotrophic lateral sclerosis (a.k.a. Lou Gehrig's disease.)

Investigators are also studying the anti-cancer activities of cannabis, as a growing body of preclinical and clinical data concludes that cannabinoids can reduce the spread of specific cancer cells via apoptosis (programmed cell death) and by the inhibition of angiogenesis

(the formation of new blood vessels). Arguably, these latter trends represent far broader and more significant applications for cannabinoid therapeutics than researchers could have imagined some thirty or even twenty years ago.

THE SAFETY PROFILE OF MEDICAL CANNABIS

Cannabinoids have a remarkable safety record, particularly when compared to other therapeutically active substances. Most significantly, the consumption of marijuana – regardless of quantity or potency -- cannot induce a fatal overdose. According to a 1995 review prepared for the World Health Organization, "There are no recorded cases of overdose fatalities attributed to cannabis, and the estimated lethal dose for humans extrapolated from animal studies is so high that it cannot be achieved by ... users."

In 2008, investigators at McGill University Health Centre and McGill University in Montreal and the University of British Columbia in Vancouver reviewed 23 clinical investigations of medicinal cannabinoid drugs (typically oral THC or liquid cannabis extracts) and eight observational studies conducted between 1966 and 2007. Investigators "did not find a higher incidence rate of serious adverse events associated with medical cannabinoid use" compared to non-using controls over these three decades.

That said, cannabis should not necessarily be viewed as a 'harmless' substance. Its active constituents may produce a variety of physiological and euphoric effects. As a result, there may be some populations that are susceptible to increased risks from the use of cannabis, such as adolescents, pregnant or nursing mothers, and patients who have a family history of mental illness. Patients with Hepatitis C, decreased lung function (such as chronic obstructive pulmonary disease), or who have a history of heart disease or stroke may also be at a greater risk of experiencing adverse side effects from marijuana. As with any medication, patients should consult thoroughly with their physician before deciding whether the medicinal use of cannabis is safe and appropriate.

HOW TO USE THIS REPORT

As states continue to approve legislation enabling the physician-supervised use of medicinal marijuana, more patients with varying disease types are exploring the use of therapeutic cannabis. Many of these patients and their physicians are now discussing this issue for the first time, and are seeking guidance on whether the therapeutic use of cannabis may or may not be advisable. This report seeks to provide this guidance by summarizing

NORML

Working to Reform Marijuana Laws

the most recently published scientific research (2000-2009) on the therapeutic use of cannabis and cannabinoids for 19 clinical indications:

- * Alzheimer's disease
- * Amyotrophic lateral sclerosis
- * Chronic Pain
- * Diabetes mellitus
- * Dystonia
- * Fibromyalgia
- * Gastrointestinal disorders
- * Gliomas
- * Hepatitis C
- * Human Immunodeficiency Virus
- * Hypertension
- * Incontinence
- * Methicillin-resistant Staphylococcus aureus (MRSA)
- * Multiple sclerosis
- * Osteoporosis
- * Pruritis
- * Rheumatoid arthritis
- * Sleep apnea
- * Tourette's syndrome

In some of these cases, modern science is now affirming longtime anecdotal reports of medicinal cannabis users (e.g., the use of cannabis to alleviate GI disorders). In other cases, this research is highlighting entirely new potential clinical utilities for cannabinoids (e.g., the use of cannabinoids to modify the progression of diabetes.)

The conditions profiled in this report were chosen because patients frequently inquire about the therapeutic use of cannabis to treat these disorders. In addition, many of the indications included in this report may be moderated by cannabis therapy. In several cases, preclinical data and clinical indicates that cannabinoids may halt the progression of these diseases in a more efficacious manner than available pharmaceuticals. In virtually all cases, this report is the most thorough and comprehensive review of the recent scientific literature regarding the therapeutic use of cannabis and cannabinoids.

NORML

Working to Reform Marijuana Laws

For patients and their physicians, let this report serve as a primer for those who are considering using or recommending medicinal cannabis. For others, let this report serve as an introduction to the broad range of emerging clinical applications for cannabis and its various compounds.

Paul Armentano
Deputy Director
NORML | NORML Foundation
Washington, DC
January 15, 2009

* The author would like to acknowledge Drs. Dale Gieringer, Gregory Carter, Steven Karch, and Mitch Earleywine, as well as Bernard Ellis, MPH, NORML interns John Lucy, Christopher Rasmussen, and Rita Bowles, for providing research assistance for this report. The NORML Foundation would also like to acknowledge Dale Gieringer, Paul Kuhn, and Richard Wolfe for their financial contributions toward the publication of this report.

** Important and timely publications such as this are only made possible when concerned citizens become involved with NORML. For more information on joining NORML or making a donation, please visit: <http://www.norml.org/join>. Tax-deductible donations in support of NORML's public education campaigns should be made payable to the NORML Foundation.

Foreword

Gregory T. Carter, MD

Department of Rehabilitation Medicine
University of Washington School of Medicine

Marijuana is a colloquial term used to refer to the dried flowers of the female *Cannabis Sativa* and *Cannabis Indica* plants. Marijuana, or cannabis, as it is more appropriately called, has been part of humanity's medicine chest for almost as long as history has been recorded.

All forms of cannabis plants are quite complex, containing over 400 chemicals. Approximately 60 of these chemicals are classified as cannabinoids. Among the most psychoactive of the cannabinoids is delta-9-tetrahydrocannabinol (THC), the active ingredient in the prescription medications dronabinol (Marinol) and naboline (Cesamet). Other major cannabinoids include cannabidiol (CBD) and cannabinol (CBN), both of which are non-psychoactive but possess distinct pharmacological effects.

Cannabis was formally introduced to the United States Pharmacopoeia (USP) in 1854, though written references regarding the plant's therapeutic use date back as far as 2800 B.C. By 1900, cannabis was the third leading active ingredient, behind alcohol and opiates, in patent medicines for sale in America. However, following the Mexican Revolution of 1910, Mexican immigrants flooded into the United States, introducing to American culture the recreational use of marijuana. Anti-drug campaigners warned against the encroaching, so-called "Marijuana Menace," and alleged that the drug's use was responsible for a wave of serious, violent criminal activity. In 1937, after testimony from Harry Anslinger -- a strong opponent of marijuana and head of the Federal Bureau of Narcotics in the 1930s -- and against the advice of the American Medical Association, the Marijuana Tax Act was pushed through Congress, effectively outlawing all possession and use of the drug.

At the time of the law's passage, there were no fewer than 28 patented medicines containing cannabis available in American drug stores with a physician's prescription. These cannabis-based medicines were produced by reputable drug companies like Squibb, Merck, and Eli Lilly, and were used safely by tens of thousands of American citizens. The enactment of the Marijuana Tax Act abruptly ended the production and use of medicinal cannabis in the United States, and by 1942 cannabis was officially removed from the *Physician's Desk Reference*.

NORML

Working to Reform Marijuana Laws

Fortunately, over the past few decades there has been a significant rebirth of interest in the viable medicinal uses of cannabis. Much of the renewed interest in cannabis as a medicine lies not only in the drug's effectiveness, but also because of its remarkably low toxicity. Lethal doses in humans have not been described. This degree of safety is very rare among modern medicines, including most over-the-counter medications. As a result, the National Institutes of Health (NIH), the National Academy of Sciences Institute of Medicine, and even the US Food and Drug Administration have all issued statements calling for further investigation into the therapeutic use of cannabis and cannabinoids.

The discovery of an endogenous cannabinoid system, with specific receptors and ligands, has progressed our understanding of the therapeutic actions of cannabis from folklore to valid science. It now appears that the cannabinoid system evolved with our species and is intricately involved in normal human physiology -- specifically in the control of movement, pain, reproduction, memory, and appetite, among other biological functions. In addition, the prevalence of cannabinoid receptors in the brain and peripheral tissues suggests that the cannabinoid system represents a previously unrecognized ubiquitous network in the nervous system.

Cannabinoid receptor sites are now known to exist in the nervous systems of all animals more advanced than hydra and mollusks. This is a result of at least 500 million years of evolution. The human body's neurological, circulatory, endocrine, digestive, and musculoskeletal systems have now all been shown to possess cannabinoid receptor sites. Indeed, even cartilage tissue has cannabinoid receptors, which makes cannabis a prime therapeutic agent to treat osteoarthritis. Cannabinoids have been shown to produce an anti-inflammatory effect by inhibiting the production and action of tumor necrosis factor (TNF) and other acute phase cytokines, which also makes them ideal compounds to treat the autoimmune forms of arthritis. It is now suggested by some researchers that these widely spread cannabinoid receptor systems are the mechanisms by which the body maintains homeostasis (the regulation of cell function), allowing the body's tissues to communicate with one another in this intricate cellular dance we call "life." With this knowledge of the widespread action of cannabinoids within all these bodily systems, it becomes much more easy to conceptualize how the various forms of cannabinoids might have a potentially therapeutic effect on diseases ranging from osteoarthritis to amyotrophic lateral sclerosis (ALS).

Another one of the exciting therapeutic areas that cannabis may impact is chronic pain. Cannabinoids produce analgesia by modulating rostral ventromedial medulla neuronal

NORML

Working to Reform Marijuana Laws

activity in a manner similar to, but pharmacologically distinct from, that of morphine. This analgesic effect is also exerted by some endogenous cannabinoids (anandamide) and synthetic cannabinoids (methanandamide). Ideally, cannabinoids could be used alone or in conjunction with opioids to treat people with chronic pain, improve their quality of life, and allow them to return to being a productive citizen.

When discussing the therapeutic use of cannabis and cannabinoids, opponents inevitably respond that patients should not smoke their medicine. Patients no longer have to. Medicinal cannabis patients who desire the rapid onset of action associated with inhalation, but who are concerned about the potential harms of noxious smoke can dramatically cut down on their intake of carcinogenic compounds by engaging in vaporization rather than smoking. Cannabis vaporization limits respiratory toxins by heating cannabis to a temperature where cannabinoid vapors form (typically around 180-190 degrees Celsius), but below the point of combustion where noxious smoke and associated toxins (e.g., carcinogenic hydrocarbons) are produced (near 230 degrees Celsius). This eliminates the inhalation of any particulate matter and removes the health hazards of smoking. In clinical trials, vaporization has been shown to safely and effectively deliver pharmacologically active, aerosolized cannabinoids deeply into the lungs, where the rich vascular bed will rapidly deliver them to tissues throughout the body.

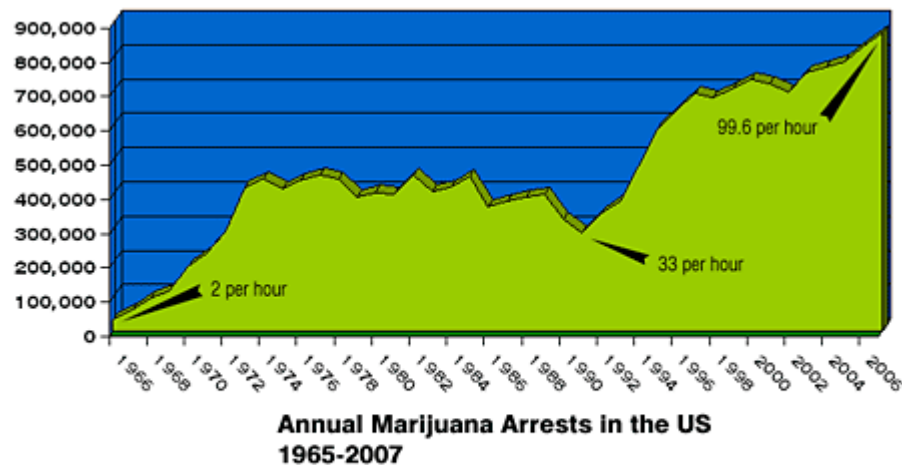
The following report summarizes the most recently published scientific research on the therapeutic use of cannabis and cannabinoids for more than a dozen diseases, including Alzheimer's, amyotrophic lateral sclerosis, diabetes, hepatitis C, multiple sclerosis, rheumatoid arthritis, and Tourette's syndrome. It is my hope that readers of this report will come away with a fair and balanced view of cannabis -- a view that is substantiated by scientific studies and not by anecdotal opinion or paranoia. Cannabis is neither a miracle compound nor the answer to everyone's ills. However, it does appear to have remarkable therapeutic benefits that are there for the taking if the governmental barriers for more intensive scientific study are removed.

The cannabis plant does not warrant the tremendous legal and societal commotion that has occurred over it. Over the past 30 years, the United States has spent billions in an effort to stem the use of illicit drugs, particularly marijuana, with limited success. Many very ill people have had to fight long court battles to defend themselves for the use of a compound that has helped them. Rational minds need to take over the war on drugs, separating myth from fact, right from wrong, and responsible, medicinal use from other less compelling behavior.

NORML

Working to Reform Marijuana Laws

The medicinal marijuana user should not be considered a criminal in any state. Most major medical groups, including the Institute of Medicine, agree that cannabis is a compound with significant therapeutic potential whose "adverse effects ... are within the range of effects tolerated for other medications." Over a decade ago, the Drug Enforcement Administration (DEA) studied the medicinal properties of cannabis. After considerable study, DEA Administrative Law Judge Francis L. Young concluded: "The evidence clearly shows that marijuana is capable of relieving the distress of great numbers of very ill people, and doing so with safety under medical supervision. ... It would be unreasonable, arbitrary and capricious for the DEA to continue to stand between those sufferers and the benefits of this substance."



NORML

The National Organization for the Reform of Marijuana Laws
www.norml.org

Despite this conclusion, over a decade later the DEA and the rest of the federal government persist in their policy of total prohibition. Nevertheless, the scientific process continues to evaluate the therapeutic effects of cannabis through ongoing research and assessment of available data. With regard to the medicinal use of cannabis, our legal system should take a similar approach, using science and logic as the basis of policy making rather than relying on political rhetoric and false perceptions regarding the alleged harmful effects of recreational marijuana use.

Alzheimer's Disease

Alzheimer's disease (AD) is a neurological disorder of unknown origin that is characterized by a progressive loss of memory and learned behavior. Patients with Alzheimer's are also likely to experience depression, agitation, and appetite loss, among other symptoms. Over 4.5 million Americans are estimated to be afflicted with the disease. No approved treatments or medications are available to stop the progression of AD, and few pharmaceuticals have been FDA-approved to treat symptoms of the disease.

A review of the recent scientific literature indicates that cannabinoid therapy may provide symptomatic relief to patients afflicted with AD while also moderating the progression of the disease.

Writing in the February 2005 issue of the *Journal of Neuroscience*, investigators at Madrid's Complutense University and the Cajal Institute in Spain reported that the intracerebroventricular administration of the synthetic cannabinoid WIN 55,212-2 prevented cognitive impairment and decreased neurotoxicity in rats injected with amyloid-beta peptide (a protein believed to induce Alzheimer's). Additional cannabinoids were also found to reduce the inflammation associated with Alzheimer's disease in human brain tissue in culture. "Our results indicate that ... cannabinoids succeed in preventing the neurodegenerative process occurring in the disease," investigators concluded.[1]

Investigators at The Scripps Research Institute in California in 2006 reported that THC inhibits the enzyme responsible for the aggregation of amyloid plaque — the primary marker for Alzheimer's disease — in a manner "considerably superior" to approved Alzheimer's drugs such as donepezil and tacrine. "Our results provide a mechanism whereby the THC molecule can directly impact Alzheimer's disease pathology," researchers concluded. "THC and its analogues may provide an improved therapeutic [option] for Alzheimer's disease [by]... simultaneously treating both the symptoms and the progression of [the] disease." [2]

Most recently, investigators at Ohio State University, Department of Psychology and Neuroscience, reported that older rats administered daily doses of WIN 55,212-2 for a period of three weeks performed significantly better than non-treated controls on a water-maze memory test. Writing in the journal *Neuroscience* in 2007, researchers reported that rats treated with the compound experienced a 50 percent improvement in memory and a 40 to 50 percent reduction in inflammation compared to controls.[3]

Previous preclinical studies have demonstrated that cannabinoids can prevent cell death by anti-oxidation.[4] Some experts believe that cannabinoids' neuroprotective properties could also play a role in moderating AD.[5] Writing in the September 2007 issue of the *British Journal of Pharmacology*, investigators at Ireland's Trinity College Institute of Neuroscience concluded, "[C]annabinoids offer a multi-faceted approach for the treatment of Alzheimer's disease by providing neuroprotection and reducing neuroinflammation, whilst simultaneously supporting the brain's intrinsic repair mechanisms by augmenting neurotrophin expression and enhancing neurogenesis. ... Manipulation of the cannabinoid pathway offers a pharmacological approach for the treatment of AD that may be efficacious than current treatment regimens." [6]

In addition to potentially modifying the progression of AD, clinical trials also indicate that cannabinoid therapy can reduce agitation and stimulate weight gain in patients with the disease. Most recently, investigators at Berlin Germany's Charite Universitatmedizin, Department of Psychiatry and Psychotherapy, reported that the daily administration of 2.5 mg of synthetic THC over a two-week period reduced nocturnal motor activity and agitation in AD patients in an open-label pilot study.[7]

Clinical data presented at the 2003 annual meeting of the International Psychogeriatric Association previously reported that the oral administration of up to 10 mg of synthetic THC reduced agitation and stimulated weight gain in late-stage Alzheimer's patients in an open-label clinical trial.[8] Improved weight gain and a decrease in negative feelings among AD patients administered cannabinoids were previously reported by investigators in the *International Journal of Geriatric Psychiatry* in 1997.[9] Additional study of the use of cannabinoids and Alzheimer's would appear to be warranted.

REFERENCES

[1] Ramirez et al. 2005. Prevention of Alzheimer's Disease pathology by cannabinoids. *The Journal of Neuroscience* 25: 1904-1913.

[2] Eubanks et al. 2006. A molecular link between the active component of marijuana and Alzheimer's disease pathology. *Molecular Pharmaceutics* (E-pub ahead of print).

[3] Marchalant et al. 2007. Anti-inflammatory property of the cannabinoid agonist WIN-55212-2 in a rodent model of chronic brain inflammation. *Neuroscience* 144: 1516-1522.

[4] Hampson et al. 1998. Cannabidiol and delta-9-tetrahydrocannabinol are neuroprotective antioxidants. *Proceedings of the National Academy of Sciences* 95: 8268-8273.

NORML

Working to Reform Marijuana Laws

[5] Science News. June 11, 1998. "Marijuana chemical tapped to fight strokes."

[6] Campbell and Gowran. 2007. Alzheimer's disease; taking the edge off with cannabinoids? *British Journal of Pharmacology* 152: 655-662.

[7] Walther et al. 2006. Delta-9-tetrahydrocannabinol for nighttime agitation in severe dementia. *Physcopharmacology* 185: 524-528.

[8] BBC News. August 21, 2003. "Cannabis lifts Alzheimer's appetite."

[9] Volicer et al. 1997. Effects of dronabinol on anorexia and disturbed behavior in patients with Alzheimer's disease. *International Journal of Geriatric Psychiatry* 12: 913-919.

Amyotrophic Lateral Sclerosis (ALS)

Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's Disease, is a fatal neurodegenerative disorder that is characterized by the selective loss of motor neurons in the spinal cord, brain stem, and motor cortex. An estimated 30,000 Americans are living with ALS, which often arises spontaneously and afflicts otherwise healthy adults. More than half of ALS patients die within 2.5 years following the onset of symptoms.

A review of the scientific literature reveals an absence of clinical trials investigating the use of cannabinoids for ALS treatment. However, recent preclinical findings indicate that cannabinoids can delay ALS progression, lending support to anecdotal reports by patients that cannabinoids may be efficacious in moderating the disease's development and in alleviating certain ALS-related symptoms such as pain, appetite loss, depression and drooling.[1]

Writing in the March 2004 issue of the journal *Amyotrophic Lateral Sclerosis & Other Motor Neuron Disorders*, investigators at the California Pacific Medical Center in San Francisco reported that the administration of THC both before and after the onset of ALS symptoms staved disease progression and prolonged survival in animals compared to untreated controls.[2]

Additional trials in animal models of ALS have shown that the administration of other naturally occurring and synthetic cannabinoids can also moderate ALS progression, but not necessarily impact survival.[3-4] One recent study demonstrated that blocking the CB1 cannabinoid receptor did extend life span in an ALS mouse model, suggesting that cannabinoids' beneficial effects on ALS may be mediated by non-CB1 receptor mechanisms.[5]

Preclinical data has also shown that cannabinoids are neuroprotective against oxidative damage both *in vitro*[6] and in animals.[7] Cannabinoids' neuroprotective action may be able to play a role in moderating ALS, which is characterized by excessive glutamate activity in the spinal cord.[8] At least one cannabinoid, delta-9-THC, has been shown to protect cultured mouse spinal neurons against excitotoxicity.[9]

As a result, some experts now recommend that "marijuana ... be considered in the pharmacological management of ALS,"[10] and they believe that "further investigation into

the usefulness of marijuana and ... synthetic cannabinoid receptor agonists is warranted.”[11]

REFERENCES

- [1] Amtmann et al. 2004. Survey of cannabis use in patients with amyotrophic lateral sclerosis. *The American Journal of Hospice and Palliative Care* 21: 95-104.
- [2] Raman et al. 2004. Amyotrophic lateral sclerosis: delayed disease progression in mice by treatment with a cannabinoid. *Amyotrophic Lateral Sclerosis & Other Motor Neuron Disorders* 5: 33-39.
- [3] Weydt et al. 2005. Cannabinol delays symptom onset in SOD1 transgenic mice without affecting survival. *Amyotrophic Lateral Sclerosis & Other Motor Neuron Disorders* 6: 182-184.
- [4] Bilsland et al. 2006. Increasing cannabinoid levels by pharmacological and genetic manipulation delay disease progression in SOD1 mice. *The FASEB Journal* 20: 1003-1005.
- [5] Ibid.
- [6] Raman et al. 2004. op.cit.
- [7] Hampson et al. 1998. Cannabidiol and delta-9-tetrahydrocannabinol are neuroprotective antioxidants. *Proceedings of the National Academy of Sciences* 95: 8268-8273.
- [8] Carter and Weydt. 2002. Cannabis: Old medicine with new promise for neurological disorders. *Current Opinion in Investigational Drugs* 3: 437-440.
- [9] Abood et al. 2001. Activation of the CB1 cannabinoid receptor protects cultured mouse spinal neurons against excitotoxicity. *Neuroscience Letters* 309: 197-201.
- [10] Carter and Rosen. 2001. Marijuana in the management of amyotrophic lateral sclerosis. *The American Journal of Hospice and Palliative Care* 18: 264-70.
- [11] Carter et al. 2003. Drug therapy for amyotrophic lateral sclerosis: Where are we now? *The Investigational Drugs Journal* 6: 147-153.

Chronic Pain

As many as one in five Americans lives with chronic pain.[1] Many of these people suffer from neuropathic pain (nerve-related pain) -- a condition that is associated with numerous diseases, including diabetes, cancer, multiple sclerosis, and HIV. In most cases, the use of standard analgesic medications such as opiates and NSAIDS (non-steroidal anti-inflammatory drugs) is ineffective at relieving neuropathic pain.

Survey data indicates that the use of cannabis is common in chronic pain populations[2], and several recent clinical trials indicate that inhaled marijuana can significantly alleviate neuropathic pain. A pair of clinical trials recently demonstrated that smoking cannabis reduces neuropathic pain in patients with HIV by more than 30 percent compared to placebo.[3-4] (Additional details on these studies appear in the HIV section of this book.)

In 2008 investigators at the University of California at Davis assessed the efficacy of inhaled cannabis on pain intensity among 38 patients with central or peripheral neuropathic pain in a randomized, placebo-controlled, crossover trial. They reported: "[C]annabis reduced pain intensity and unpleasantness equally. Thus, as with opioids, cannabis does not rely on a relaxing or tranquilizing effect, but rather reduces both the core component of nociception (nerve pain) and the emotional aspect of the pain experience to an equal degree." [5]

Preclinical data indicates that cannabinoids, when administered in concert with one another, are more effective at ameliorating neuropathic pain than the use of a single agent. Investigators at the University of Milan reported in 2008 that the administration of single cannabinoids such as THC or CBD produce limited relief compared to the administration of plant extracts containing multiple cannabinoids, terpenes (oils), and flavonoids (pigments).

Researchers concluded: "[T]he use of a standardized extract of *Cannabis sativa* ... evoked a total relief of thermal hyperalgesia, in an experimental model of neuropathic pain, ... ameliorating the effect of single cannabinoids," investigators concluded. ... Collectively, these findings strongly support the idea that the combination of cannabinoid and non-cannabinoid compounds, as present in [plant-derived] extracts, provide significant advantages in the relief of neuropathic pain compared with pure cannabinoids alone. ... Further studies of cannabis-based medicines in neuropathic pain are now required to demonstrate a clinically relevant improvement in the treatment of this condition." [6]

REFERENCES

NORML

Working to Reform Marijuana Laws

- [1] New York Times. October 21, 1994. "Study says 1 in 5 Americans suffers from chronic pain."
- [2] Cone et al. 2008. Urine drug testing of chronic pain patients: licit and illicit drug patterns. *Journal of Analytical Toxicology* 32: 532-543.
- [3] Abrams et al. 2007. Cannabis in painful HIV-associated sensory neuropathy: a randomized placebo-controlled trial. *Neurology* 68: 515-521.
- [4] Ellis et al. 2008. Smoked medicinal cannabis for neuropathic pain in HIV: a randomized, crossover clinical trial. *Neuropsychopharmacology* [E-pub ahead of print].
- [5] Wilsey et al. 2008. A randomized, placebo-controlled, crossover trial of cannabis cigarettes in neuropathic pain. *Journal of Pain* 9: 506-521.
- [6] Comelli et al. 2008. Antihyperalgesic effect of a Cannabis sativa extract in a rat model of neuropathic pain. *Phytotherapy Research* 22: 1017-1024.

Diabetes Mellitus

Diabetes mellitus is a group of autoimmune diseases characterized by defects in insulin secretion resulting in hyperglycemia (an abnormally high concentration of glucose in the blood). There are two primary types of diabetes. Individuals diagnosed with type 1 diabetes (also known as juvenile diabetes) are incapable of producing pancreatic insulin and must rely on insulin medication for survival. Individuals diagnosed with type 2 diabetes (also known as adult onset diabetes) produce inadequate amounts of insulin. Type 2 diabetes is a less serious condition that typically is controlled by diet. Over time, diabetes can lead to blindness, kidney failure, nerve damage, hardening of the arteries, and death. The disease is the third leading cause of death in the United States after heart disease and cancer.

A search of the scientific literature reveals no clinical investigations of cannabis for the treatment of diabetes, but does identify a small number of preclinical studies indicating that cannabinoids may modify the disease's progression and provide symptomatic relief to those suffering from it.[1-2] Most recently, a study published in the journal *Autoimmunity* reported that injections of 5 mg per day of the non-psychoactive cannabinoid CBD significantly reduced the incidence of diabetes in mice. Investigators reported that 86% of untreated control mice in the study developed diabetes. By contrast, only 30% of CBD-treated mice developed the disease.[3] In a separate experiment, investigators reported that control mice all developed diabetes at a median of 17 weeks (range 15-20 weeks), while a majority (60 percent) of CBD-treated mice remained diabetes-free at 26 weeks.[4]

Investigators also found that CBD significantly lowered plasma levels of the pro-inflammatory cytokines (proteins) INF-gamma and TNF-alpha and significantly reduced the severity of insulinitis (an infiltration of white blood cells resulting in swelling) compared to non-treated controls. "Our results indicate that CBD can inhibit and delay destructive insulinitis and inflammatory ... cytokine production in ... mice resulting in decreased incidence of diabetes," authors concluded.

Other preclinical trials have demonstrated cannabinoids to possess additional beneficial effects in animal models of diabetes. Writing in the March 2006 issue of the *American Journal of Pathology*, researchers at the Medical College of Virginia reported that rats treated with CBD for periods of one to four weeks experienced significant protection from diabetic retinopathy.[5] This condition, which is characterized by retinal oxygen deprivation and a breakdown of the blood-retinal barrier, is the leading cause of blindness in working-age adults.

Cannabinoids have also been shown to alleviate neuropathic pain associated with the disease. A pair of studies published in the journal *Neuroscience Letters* in 2004 reported that mice administered a cannabis receptor agonist experienced a reduction in diabetic-related tactile allodynia (pain resulting from non-injurious stimulus to the skin) compared to non-treated controls.[6-7] The findings suggest that "cannabinoids have a potential beneficial effect on experimental diabetic neuropathic pain."

Finally, a 2001 trial demonstrated that delta-9-THC could moderate an animal model of the disease by reducing artificially-elevated glucose levels and insulinitis in mice compared to non-treated controls.[8] With the incidence of diabetes steadily increasing in both the adult and juvenile population, it would appear that further cannabinoid research is warranted in the treatment of these diseases.

REFERENCES

[1] Croxford and Yamamura. 2005. Cannabinoids and the immune system: Potential for the treatment of inflammatory diseases. *Journal of Neuroimmunology* 166: 3-18.

[2] Lu et al. 2006. The cannabinergic system as a target for anti-inflammatory therapies. *Current Topics in Medicinal Chemistry* 13: 1401-1426.

[3] Weiss et al. 2006. Cannabidiol lowers incidence of diabetes in non-obese diabetic mice. *Autoimmunity* 39: 143-151.

[4] Ibid

[5] El-Remessy et al. 2006. Neuroprotective and blood-retinal barrier preserving effects of cannabidiol in experimental diabetes. *American Journal of Pathology* 168: 235-244.

[6] Dogrul et al. 2004. Cannabinoids block tactile allodynia in diabetic mice without attenuation of its antinociceptive effect. *Neuroscience Letters* 368: 82-86.

[7] Ulugol et al. 2004. The effect of WIN 55,212-2, a cannabinoid agonist, on tactile allodynia in diabetic rats. *Neuroscience Letters* 71: 167-170.

[8] Li et al. 2001. Examination of the immunosuppressive effect of delta-9-tetrahydrocannabinol in streptozotocin-induced autoimmune diabetes. *International Immunopharmacology (Italy)* 4: 699-712.

Dystonia

Dystonia is a neurological movement disorder characterized by abnormal muscle tension and involuntary, painful muscle contractions. It is the third most common movement disorder after Parkinson's disease and tremor, affecting more than 300,000 people in North America.

A small number of case reports and preclinical studies investigating the use of cannabis and cannabinoids for symptoms of dystonia are referenced in the recent scientific literature. A 2002 case study published in the July issue of the *The Journal of Pain and Symptom Management* reported improved symptoms of dystonia after smoking cannabis in a 42-year-old chronic pain patient. Investigators reported that subject's subjective pain score fell from 9 to zero (on a zero-to-10 visual analog scale) following cannabis inhalation, and that the subject did not require any additional analgesic medication for the following 48 hours. "No other treatment intervention to date had resulted in such dramatic overall improvement in [the patient's] condition," investigators concluded.[1]

A second case study reporting "significant clinical improvement" following cannabis inhalation in a single 25-year-old patient with generalized dystonia due to Wilson's disease was documented by an Argentinian research team in the August 2004 issue of the journal *Movement Disorders*. [2]

Also in 2004, a German research team at the Hannover Medical School reported successful treatment of musician's dystonia in a 38-year-old professional pianist following administration of 5 mg of THC in a placebo-controlled single-dose trial.[3] Investigators reported "clear improvement of motor control" in the subject's affected hand, and noted, "[Two] hours after THC intake, the patient was able to play technically demanding literature, which had not been possible before treatment." Prior to cannabinoid treatment, the subject had been unresponsive to standard medications and was no longer performing publicly. "The results provide evidence that ... THC intake ... significantly improves [symptoms of] ... focal dystonia," investigators concluded.

By contrast, a 2002 randomized, placebo-controlled study investigating the use of the synthetic oral cannabinoid nabilone (Cesamet) in 15 patients afflicted with generalized and segmental primary dystonia did not show a significant reduction in dystonic symptoms.[4] Investigators speculated that this result may have been dose-related, and that administration of a higher dosage may have yielded a different outcome.

At least one recent preclinical trial indicates that both synthetic cannabinoids as well as high doses of the natural non-psychoactive cannabinoid cannabidiol (CBD) could moderate the disease progression of dystonia in animals.[5] Limited references regarding the use of cannabinoids for dystonia in humans[6] and animals[7] in the 1980s and the 1990s also appear in the scientific literature. It would appear that additional, larger clinical trials are warranted to investigate the use of cannabis and cannabinoids for this indication.

REFERENCES

- [1] Chatterjee et al. 2002. A dramatic response to inhaled cannabis in a woman with central thalamic pain and dystonia. *The Journal of Pain and Symptom Management* 24: 4-6.
- [2] Roca et al. 2004. Cannabis sativa and dystonia secondary to Wilson's disease. *Movement Disorders* 20: 113-115.
- [3] Jabusch et al. 2004. Delta-9-tetrahydrocannabinol improves motor control in a patient with musician's dystonia (PDF). *Movement Disorders* 19: 990-991.
- [4] Fox et al. 2002. Randomised, double-blind, placebo-controlled trial to assess the potential of cannabinoid receptor stimulation in the treatment of dystonia. *Movement Disorders* 17: 145-149.
- [5] Richter et al. 2002. Effects of pharmacological manipulations of cannabinoid receptors on severe dystonia in a genetic model of paroxysmal dyskinesia. *European Journal of Pharmacology* 454: 145-151.
- [6] Consroe et al. 1986. Open label evaluation of cannabidiol in dystonic movement disorders. *International Journal of Neuroscience* 30: 277-282.
- [7] Richter et al. 1994. (+)-WIN 55212-2, a novel cannabinoid agonist, exerts antidystonic effects in mutant dystonic hamsters. *European Journal of Pharmacology* 264: 371-377.

Fibromyalgia

Fibromyalgia is a chronic pain syndrome of unknown etiology. The disease is characterized by widespread musculoskeletal pain, fatigue, and multiple tender points in the neck, spine, shoulders, and hips. An estimated 3 to 6 million Americans are afflicted by fibromyalgia, which is often poorly controlled by standard pain medications.

Fibromyalgia patients frequently self-report using cannabis therapeutically to treat symptoms of the disease,[1-2] and physicians – where legal to do so – often recommend the use of cannabis to treat musculoskeletal disorders.[3-4] To date however, only one clinical trial is available in the scientific literature assessing the use of cannabinoids to treat the disease.

Writing in the July 2006 issue of the journal *Current Medical Research and Opinion*, investigators at Germany's University of Heidelberg evaluated the analgesic effects of oral THC in nine patients with fibromyalgia over a 3-month period. Subjects in the trial were administered daily doses of 2.5 to 15 mg of THC, but received no other pain medication during the trial. Among those participants who completed the trial, all reported a significant reduction in daily recorded pain and electronically induced pain.[5]

Previous clinical and preclinical trials have shown that both naturally occurring and endogenous cannabinoids hold analgesic qualities,[6-9] particularly in the treatment of cancer pain [10] and neuropathic pain, [11-13] both of which are poorly treated by conventional opioids. As a result, some experts have suggested that cannabinoid agonists would be applicable for the treatment of chronic pain conditions unresponsive to opioid analgesics such as fibromyalgia, and they theorize that the disease may be associated with an underlying clinical deficiency of the endocannabinoid system.[14]

REFERENCES

- [1] Swift et al. 2005. Survey of Australians using cannabis for medical purposes. *Harm Reduction Journal* 4: 2-18.
- [2] Ware et al. 2005. The medicinal use of cannabis in the UK: results of a nationwide survey. *International Journal of Clinical Practice* 59: 291-295.
- [3] Dale Gieringer. 2001. Medical use of cannabis: experience in California. In: Grotenhermen and Russo (Eds). *Cannabis and Cannabinoids: Pharmacology, Toxicology, and Therapeutic Potential*. New York: Haworth Press: 153-170.

- [4] Gorter et al. 2005. Medical use of cannabis in the Netherlands. *Neurology* 64: 917-919.
- [5] Schley et al. 2006. Delta-9-THC based monotherapy in fibromyalgia patients on experimentally induced pain, axon reflex flare, and pain relief. *Current Medical Research and Opinion* 22: 1269-1276.
- [6] Burns and Ineck. 2006. Cannabinoid analgesia as a potential new therapeutic option in the treatment of chronic pain. *The Annals of Pharmacotherapy* 40: 251-260.
- [7] David Secko. 2005. Analgesia through endogenous cannabinoids. *CMAJ* 173:
- [8] Wallace et al. 2007. Dose-dependent effects of smoked cannabis on capsaicin-induced pain and hyperalgesia in healthy volunteers. *Anesthesiology* 107:785-96.
- [9] Cox et al. 2007. Synergy between delta9-tetrahydrocannabinol and morphine in the arthritic rat. *European Journal of Pharmacology* 567: 125-130.
- [10] Radbruch and Elsner. 2005. Emerging analgesics in cancer pain management. *Expert Opinion on Emerging Drugs* 10: 151-171.
- [11] Notcutt et al. 2004. Initial experiences with medicinal extracts of cannabis for chronic pain: Results from 34 'N of 1' studies. *Anaesthesia* 59: 440.
- [12] Abrams et al. 2007. Cannabis in painful HIV-associated sensory neuropathy: a randomized placebo-controlled trial. *Neurology*: 68: 515-521.
- [13] Rog et al. 2007. Oromucosal delta-9-tetrahydrocannabinol/cannabidiol for neuropathic pain associated with multiple sclerosis: an uncontrolled, open-label, 2-year extension trial. *Clinical Therapeutics* 29: 2068-2079.
- [14] Ethan Russo. 2004. Clinical Endocannabinoid deficiency (CECD): Can this concept explain therapeutic benefits of cannabis in migraine, fibromyalgia, irritable bowel syndrome, and other treatment-resistant conditions? *Neuroendocrinology Letters* 25: 31-39.

Gastrointestinal Disorders

Gastrointestinal (GI) disorders, including functional bowel diseases such as irritable bowel syndrome (IBS) and inflammatory bowel diseases such as Crohn's disease and colitis, afflict more than one in five Americans, particularly women. While some GI disorders may be controlled by diet and pharmaceutical medications, others are poorly moderated by conventional treatments. Symptoms of GI disorders often include cramping, abdominal pain, inflammation of the lining of the large and/or small intestine, chronic diarrhea, rectal bleeding, and weight loss.

Although several anecdotal reports[1-2] and a handful of case reports[3-4] exist in the scientific literature supporting the use of cannabinoids to treat symptoms of GI disorders, virtually no clinical trial work has been performed in this area, aside from a 2007 clinical study assessing the impact of oral THC on colonic motility.[5]

However, numerous preclinical studies demonstrate that activation of the CB1 and CB2 cannabinoid receptors exert biological functions on the gastrointestinal tract.[6] Effects of their activation in animals include suppression of gastrointestinal motility,[7] inhibition of intestinal secretion,[8] reduced acid reflux,[9] and protection from inflammation[10], as well as the promotion of epithelial wound healing in human tissue.[11] As a result, many experts now believe that cannabinoids and/or modulation of the endogenous cannabinoid system represents a novel therapeutic target for the treatment of numerous GI disorders — including inflammatory bowel diseases, functional bowel diseases, gastro-oesophagael reflux conditions, secretory diarrhea, gastric ulcers, and colon cancer.[12-13]

REFERENCES

- [1] Gahlinger, Paul M. 1984. Gastrointestinal illness and cannabis use in a rural Canadian community. *Journal of Psychoactive Drugs* 16: 263-265.
- [2] Swift et al. 2005. Survey of Australians using cannabis for medical purposes. *Harm Reduction Journal* 4: 2-18.
- [3] Baron et al. 1990. Ulcerative colitis and marijuana. *Annals of Internal Medicine* 112: 471.
- [4] Jeff Hergenrather. 2005. Cannabis alleviates symptoms of Crohn's Disease. *O'Shaughnessy's* 2: 3.
- [5] Esfandyari et al. 2007. Effects of a cannabinoid receptor agonist on colonic motor and sensory functions in humans: a randomized, placebo-controlled study. *American Journal of Physiology, Gastrointestinal and Liver Physiology* 293: 137-145.

- [6] Massa and Monory. 2006. Endocannabinoids and the gastrointestinal tract. *Journal of Endocrinological Investigation* 29 (Suppl): 47-57.
- [7] Roger Pertwee. 2001. Cannabinoids and the gastrointestinal tract. *Gut* 48: 859-867.
- [8] DiCarlo and Izzo. 2003. Cannabinoids for gastrointestinal diseases: potential therapeutic applications. *Expert Opinion on Investigational Drugs* 12: 39-49.
- [9] Lehmann et al. 2002. Cannabinoid receptor agonism inhibits transient lower esophageal sphincter relaxations and reflux in dogs. *Gastroenterology* 123: 1129-1134.
- [10] Massa et al. 2005. The endocannabinoid system in the physiology and pathophysiology of the gastrointestinal tract. *Journal of Molecular Medicine* 12: 944-954.
- [11] Wright et al. 2005. Differential expression of cannabinoid receptors in the human colon: cannabinoids promote epithelial wound healing. *Gastroenterology* 129: 437-453.
- [12] Massa and Monory. 2006. op. cit.
- [13] Izzo and Coutts. 2005. Cannabinoids and the digestive tract. *Handbook of Experimental Pharmacology* 168: 573-598.

Gliomas

Gliomas (tumors in the brain) are especially aggressive malignant forms of cancer, often resulting in the death of affected patients within one to two years following diagnosis. There is no cure for gliomas and most available treatments provide only minor symptomatic relief.

A review of the modern scientific literature reveals numerous preclinical studies and one pilot clinical study demonstrating cannabinoids' ability to act as antineoplastic agents, particularly on glioma cell lines.

Writing in the September 1998 issue of the journal *FEBS Letters*, investigators at Madrid's Complutense University, School of Biology, first reported that delta-9-THC induced apoptosis (programmed cell death) in glioma cells in culture.[1] Investigators followed up their initial findings in 2000, reporting that the administration of both THC and the synthetic cannabinoid agonist WIN 55,212-2 "induced a considerable regression of malignant gliomas" in animals.[2] Researchers again confirmed cannabinoids' ability to inhibit tumor growth in animals in 2003.[3]

That same year, Italian investigators at the University of Milan, Department of Pharmacology, Chemotherapy and Toxicology, reported that the non-psychoactive cannabinoid, cannabidiol (CBD), inhibited the growth of various human glioma cell lines *in vivo* and *in vitro* in a dose dependent manner. Writing in the November 2003 issue of the *Journal of Pharmacology and Experimental Therapeutics Fast Forward*, researchers concluded, "Non-psychoactive CBD ... produce[s] a significant anti-tumor activity both *in vitro* and *in vivo*, thus suggesting a possible application of CBD as an antineoplastic agent." [4]

In 2004, Guzman and colleagues reported that cannabinoids inhibited glioma tumor growth in animals and in human glioblastoma multiforme (GBM) tumor samples by altering blood vessel morphology (e.g., VEGF pathways). Writing in the August 2004 issue of *Cancer Research*, investigators concluded, "The present laboratory and clinical findings provide a novel pharmacological target for cannabinoid-based therapies." [5]

More recently, investigators at the California Pacific Medical Center Research Institute reported that the administration of THC on human glioblastoma multiforme cell lines decreased the proliferation of malignant cells and induced cell death more rapidly than did the administration of WIN 55,212-2. Researchers also noted that THC selectively targeted

malignant cells while ignoring healthy ones in a more profound manner than the synthetic alternative.[6]

Most recently, Guzman and colleagues reported that THC administration decreases recurrent glioblastoma multiforme tumor growth in patients diagnosed with recurrent GBM. In the first ever pilot clinical trial assessing the use of cannabinoids and GBM, investigators found that the intratumoral administration of THC was associated with reduced tumor cell proliferation in two of nine subjects. "The fair safety profile of THC, together with its possible anti-proliferative action on tumor cells reported here and in other studies, may set the basis for future trials aimed at evaluating the potential antitumoral activity of cannabinoids," investigators concluded.[7] Several additional investigators have also recently called for further exploration of cannabis-based therapies for the treatment of glioma.[8-10]

In addition to cannabinoids' ability to moderate glioma cells, separate studies demonstrate that cannabinoids and endocannabinoids can also inhibit the proliferation of other various cancer cell lines, including breast carcinoma,[11-14] prostate carcinoma,[15-17] colorectal carcinoma,[18] gastric adenocarcinoma,[19] skin carcinoma,[20] leukemia cells,[21-22] neuroblastoma,[23] lung carcinoma,[24-25] uterus carcinoma,[26] thyroid epithelioma,[27] pancreatic adenocarcinoma,[28-29], cervical carcinoma[30] and lymphoma.[31-32]

Studies also indicate that the administration of cannabinoids, in conjunction with conventional anti-cancer therapies, can enhance the effectiveness of standard cancer treatments.[33]

Consequently, many experts now believe that cannabinoids "may represent a new class of anticancer drugs that retard cancer growth, inhibit angiogenesis and the metastatic spreading of cancer cells," [34-35] and have recommended that at least one cannabinoid, cannabidiol, now be utilized in cancer therapy.[36]

REFERENCES

- [1] Guzman et al. 1998. Delta-9-tetrahydrocannabinol induces apoptosis in C6 glioma cells. *FEBS Letters* 436: 6-10.
- [2] Guzman et al. 2000. Anti-tumoral action of cannabinoids: involvement of sustained ceramide accumulation and extracellular signal-regulated kinase activation. *Nature Medicine* 6: 313-319.
- [3] Guzman et al. 2003. Inhibition of tumor angiogenesis by cannabinoids. *The FASEB Journal* 17: 529-531.

- [4] Massi et al. 2004. Antitumor effects of cannabidiol, a non-psychotropic cannabinoid, on human glioma cell lines. *Journal of Pharmacology and Experimental Therapeutics Fast Forward* 308: 838-845.
- [5] Guzman et al. 2004. Cannabinoids inhibit the vascular endothelial growth factor pathways in gliomas (PDF). *Cancer Research* 64: 5617-5623.
- [6] Allister et al. 2005. Cannabinoids selectively inhibit proliferation and induce death of cultured human glioblastoma multiforme cells. *Journal of Neurooncology* 74: 31-40.
- [7] Guzman et al. 2006. A pilot clinical study of delta-9-tetrahydrocannabinol in patients with recurrent glioblastoma multiforme. *British Journal of Cancer* (E-pub ahead of print).
- [8] Parolaro and Massi. 2008. Cannabinoids as a potential new drug therapy for the treatment of gliomas. *Expert Reviews of Neurotherapeutics* 8: 37-49
- [9] Galanti et al. 2007. Delta9-Tetrahydrocannabinol inhibits cell cycle progression by downregulation of E2F1 in human glioblastoma multiforme cells. *Acta Oncologica* 12: 1-9.
- [10] Calatuzzolo et al. 2007. Expression of cannabinoid receptors and neurotrophins in human gliomas. *Neurological Sciences* 28: 304-310.
- [11] Cafferlati et al. 2006. Delta-9-Tetrahydrocannabinol inhibits cell cycle progression in human breast cancer cells through Cdc2 regulation. *Cancer Research* 66: 6615-6621.
- [12] Di Marzo et al. 2006. Anti-tumor activity of plant cannabinoids with emphasis on the effect of cannabidiol on human breast carcinoma. *Journal of Pharmacology and Experimental Therapeutics Fast Forward* (E-pub ahead of print).
- [13] De Petrocellis et al. 1998. The endogenous cannabinoid anandamide inhibits human breast cancer cell proliferation. *Proceedings of the National Academy of Sciences of the United States of America* 95: 8375-8380.
- [14] McAllister et al. 2007. Cannabidiol as a novel inhibitor of Id-1 gene expression in aggressive breast cancer cells. *Molecular Cancer Therapeutics* 6: 2921-2927.
- [15] Sarfaraz et al. 2005. Cannabinoid receptors as a novel target for the treatment of prostate cancer. *Cancer Research* 65: 1635-1641.
- [16] Mimeault et al. 2003. Anti-proliferative and apoptotic effects of anandamide in human prostatic cancer cell lines. *Prostate* 56: 1-12.
- [17] Ruiz et al. 1999. Delta-9-tetrahydrocannabinol induces apoptosis in human prostate PC-3 cells via a receptor-independent mechanism. *FEBS Letters* 458: 400-404.

- [18] Pastos et al. 2005. The endogenous cannabinoid, anandamide, induces cell death in colorectal carcinoma cells: a possible role for cyclooxygenase-2. *Gut* 54: 1741-1750.
- [19] Di Marzo et al. 2006. op. cit
- [20] Casanova et al. Inhibition of skin tumor growth and angiogenesis in vivo by activation of cannabinoid receptors. 2003. *Journal of Clinical Investigation* 111: 43-50.
- [21] Powles et al. 2005. Cannabis-induced cytotoxicity in leukemic cell lines. *Blood* 105: 1214-1221
- [22] Jia et al 2006. Delta-9-tetrahydrocannabinol-induced apoptosis is jurkat leukemic T cells in regulated by translocation of Bad to mitochondria. *Molecular Cancer Research* 4: 549-562.
- [23] Manuel Guzman. 2003. Cannabinoids: potential anticancer agents (PDF). *Nature Reviews Cancer* 3: 745-755.
- [24] Ibid.
- [25] Preet et al. 2008. Delta9-Tetrahydrocannabinol inhibits epithelial growth factor-induced lung cancer cell migration in vitro as well as its growth and metastasis in vivo. *Oncogene* 10: 339-346.
- [26] Manuel Guzman. 2003. Cannabinoids: potential anticancer agents (PDF). *Nature Reviews Cancer* 3: 745-755.
- [27] Baek et al. 1998. Antitumor activity of cannabigerol against human oral epitheloid carcinoma cells. *Archives of Pharmacal Research*: 21: 353-356.
- [28] Carracedo et al. 2006. Cannabinoids induce apoptosis of pancreatic tumor cells via endoplasmic reticulum stress-related genes. *Cancer Research* 66: 6748-6755.
- [29] Michalski et al. 2007. Cannabinoids in pancreatic cancer: correlation with survival and pain. *International Journal of Cancer* (E-pub ahead of print).
- [30] Ramer and Hinz. 2008. Inhibition of cancer cell invasion by cannabinoids via increased cell expression of tissue inhibitor of matrix metalloproteinases-1. *Journal of the National Cancer Institute* 100: 59-69.
- [31] Gustafsson et al. 2006. Cannabinoid receptor-mediated apoptosis induced by R(+)-methanandamide and Win55,212 is associated with ceramide accumulation and p38 activation in Mantle Cell Lymphoma. *Molecular Pharmacology* (E-pub ahead of print).
- [32] Gustafsson et al. 2008. Expression of cannabinoid receptors type 1 and type 2 in non-Hodgkin lymphoma: Growth inhibition by receptor activation. *International Journal of Cancer* 123: 1025-1033.
- [33] Liu et al. 2008. Enhancing the *in_vitro* cytotoxic activity of Δ9-tetrahydrocannabinol in leukemic cells through a combinatorial approach. *Leukemia and Lymphoma* 49: 1800-1809.

NORML

Working to Reform Marijuana Laws

[34] Natalya Kogan. 2005. Cannabinoids and cancer. *Mini-Reviews in Medicinal Chemistry* 5: 941-952.

[35] Sarafaraz et al. 2008. Cannabinoids for cancer treatment: progress and promise. *Cancer Research* 68: 339-342.

[36] Di Marzo et al. 2006. op. cit.

Hepatitis C

Hepatitis C is a viral disease of the liver that afflicts an estimated four million Americans. Chronic hepatitis C is typically associated with fatigue, depression, joint pain and liver impairment, including cirrhosis and liver cancer.

Patients diagnosed with hepatitis C frequently report using cannabis to treat both symptoms of the disease as well as the nausea associated with antiviral therapy.[1-2] An observational study by investigators at the University of California at San Francisco (UCSF) found that hepatitis C patients who used cannabis were significantly more likely to adhere to their treatment regimen than patients who didn't use it. [3] Nevertheless, no clinical trials assessing the use of cannabinoids for this indication are available in the scientific literature.

Preclinical data indicates that the endocannabinoid system may moderate aspects of chronic liver disease[4-5] and that cannabinoids may reduce inflammation in experimental models of hepatitis.[6] However, other clinical reviews have reported a positive association between daily cannabis use and the progression of liver fibrosis (excessive tissue build up) and steatosis (excessive fat build up) in select hepatitis C patients. [7-9]

As a result, experts hold divergent opinions regarding the therapeutic use of cannabinoids for hepatitis C treatment. Writing in the October 2006 issue of the *European Journal of Gastroenterology*, investigators from Canada and Germany concluded that cannabis' "potential benefits of a higher likelihood of treatment success [for hepatitis c patients] appear to outweigh [its] risks." [10] By contrast, other experts discourage the use of cannabis in patients with chronic hepatitis until further studies are performed.[11-14]

REFERENCES

[1] Schnelle et al. 1999. Results of a standardized survey on the medical use of cannabis products in the German-speaking area. *Forschende Komplementarmedizin (Germany)* 3: 28-36.

[2] David Berstein. 2004. "Hepatitis C – Current state of the art and future directions." *MedScape Today*.

[3] Sylvestre et al. 2006. Cannabis use improves retention and virological outcomes in patients treated for hepatitis C. *European Journal of Gastroenterology & Hepatology*. 18: 1057-1063.

[4] Zamora-Valdes et al. 2005. The endocannabinoid system in chronic liver disease (PDF). *Annals of Hepatology* 4: 248-254.

- [5] Gabbey et al. 2005. Endocannabinoids and liver disease – review. *Liver International* 25: 921-926.
- [6] Lavon et al. 2003. A novel synthetic cannabinoid derivative inhibits inflammatory liver damage via negative cytokine regulation. *Molecular Pharmacology* 64: 1334-1344.
- [7] Hezode et al. 2005. Daily cannabis smoking as a risk factor for progression of fibrosis in chronic hepatitis C. *Hepatology* 42: 63-71.
- [8] Ishida et al. 2008. Influence of cannabis use on severity of hepatitis C disease. *Clinical Gastroenterology and Hepatology* 6: 69-75.
- [9] Parfieniuk and Flisiak. 2008. Role of cannabinoids in liver disease. *World Journal of Gastroenterology* 14: 6109-6114.
- [10] Fischer et al. 2006. Treatment for hepatitis C virus and cannabis use in illicit drug user patients: implications and questions. *European Journal of Gastroenterology & Hepatology*. 18: 1039-1042.
- [11] Schwabe and Siegmund. 2005. op. cit.
- [12] Hezode et al. 2005. op. cit.
- [13] David Bernstein. 2004. op. cit.
- [14] Hezode et al. 2008. Daily cannabis use: a novel risk factor of steatosis severity in patients with chronic hepatitis C. *Gastroenterology* 134: 432-439.

Human Immunodeficiency Virus (HIV)

The human immunodeficiency virus is a retrovirus that invades cells in the human immune system, making it highly susceptible to infectious diseases. According to the World Health Organization, over 500,000 Americans have died from HIV/AIDS and over one million US citizens are living with the disease.

Survey data indicates that cannabis is used by as many one in three North American patients with HIV/AIDS to treat symptoms of the disease as well as the side-effects of various antiretroviral medications,[1-4] with one recent study reporting that more than 60 percent of HIV/AIDS patients self-identify as "medical cannabis users." [5] Patients living with HIV/AIDS most frequently report using cannabis to counter symptoms of anxiety, appetite loss, and nausea, and at least one study has reported that patients who use cannabis therapeutically are 3.3 times more likely to adhere to their antiretroviral therapy regimens than non-cannabis users.[6]

Clinical trial data indicates that cannabis use does not adversely impact CD4 and CD8 T cell counts,[7] and may even improve immune function.[8-9]

In 2007, investigators at Columbia University published clinical trial data in 2007 reporting that HIV/AIDS patients who inhaled cannabis four times daily experienced "substantial ... increases in food intake ... with little evidence of discomfort and no impairment of cognitive performance." They concluded, "Smoked marijuana ... has a clear medical benefit in HIV-positive [subjects]" [10]

That same year, investigators at San Francisco General Hospital and the University of California's Pain Clinical Research Center reported in the journal *Neurology* that inhaling cannabis significantly reduced HIV-associated neuropathy compared to placebo. Researchers reported that inhaling cannabis three times daily reduced patients' pain by 34 percent. They concluded, "Smoked cannabis was well tolerated and effectively relieved chronic neuropathic pain from HIV-associated neuropathy [in a manner] similar to oral drugs used for chronic neuropathic pain." [11]

In 2008, researchers at the University of California at San Diego reported similar findings. Writing in the journal *Neuropsychopharmacology*, they concluded: "Smoked cannabis ... significantly reduced neuropathic pain intensity in HIV-associated ... polyneuropathy compared to placebo, when added to stable concomitant analgesics. ... Mood disturbance,

physical disability, and quality of life all improved significantly during study treatment. ... Our findings suggest that cannabinoid therapy may be an effective option for pain relief in patients with medically intractable pain due to HIV." [12]

As a result, many experts now believe that "marijuana represents another treatment option in [the] health management" of patients with HIV/AIDS.[13]

REFERENCES

- [1] Woolridge et al. 2005. Cannabis use in HIV for pain and other medical symptoms. *Journal of Pain Symptom Management* 29: 358-367.
- [2] Prentiss et al. 2004. Patterns of marijuana use among patients with HIV/AIDS followed in a public health care setting [PDF]. *Journal of Acquired Immune Deficiency Syndromes* 35: 38-45.
- [3] Braitstein et al. 2001. Mary-Jane and her patients: sociodemographic and clinical characteristics of HIV-positive individuals using medical marijuana and antiretroviral agents. *AIDS* 12: 532-533..
- [4] Ware et al. 2003. Cannabis use by persons living with HIV/AIDS: patterns and prevalence of use. *Journal of Cannabis Therapeutics* 3: 3-15.
- [5] Belle-Isle and Hathaway. 2007. Barriers to access to medical cannabis for Canadians living with HIV/AIDS. *AIDS Care* 19: 500-506.
- [6] de Jong et al. 2005. Marijuana use and its association with adherence to antiretroviral therapy among HIV-infected persons with moderate to severe nausea. *Journal of Acquired Immune Deficiency Syndromes* 38: 43-46.
- [7] Chao et al. 2008. Recreational drug use and T lymphocyte subpopulations in HIV-uninfected and HIV-infected men. *Drug and Alcohol Dependence*. (E-pub ahead of print).
- [8] Abrams et al. 2003. Short-term effects of cannabinoids in patients with HIV-1 infection: a randomized, placebo-controlled clinical trial. *Annals of Internal Medicine* 139: 258-266.
- [9] Fogarty et al. 2007. Marijuana as therapy for people living with HIV/AIDS: social and health aspects 19: 295-301.
- [10] Haney et al. 2007. Dronabinol and marijuana in HIV-positive marijuana smokers: caloric intake, mood, and sleep. *Journal of Acquired Immune Deficiency Syndromes* 45: 545-554.
- [11] Abrams et al. 2007 op. cit.

[12] Ellis et al. 2008. op. cit.

[13] Fogarty et al. 2007. op. cit.

Hypertension

High blood pressure, or hypertension, afflicts an estimated 1 in 4 American adults. This condition puts a strain on the heart and blood vessels and greatly increases the risk of stroke and heart disease.

Emerging research indicates that the endogenous cannabinoid system plays a role in regulating blood pressure, though its mechanism of action is not well understood.[1] Animal studies demonstrate that anandamide and other endocannabinoids profoundly suppress cardiac contractility in hypertension and can normalize blood pressure,[2-3] leading some experts to speculate that the manipulation of the endocannabinoid system “may offer novel therapeutic approaches in a variety of cardiovascular disorders.”[4]

The administration of natural cannabinoids has yielded conflicting cardiovascular effects on humans and laboratory animals.[5-9] The vascular response in humans administered cannabis in experimental conditions is typically characterized by a mild increase in heart rate and blood pressure. However, complete tolerance to these effects develops quickly and potential health risks appear minimal.[10-11]

In animals, cannabinoid administration in animals is typically associated with vasodilation, transient bradycardia and hypotension,[12] as well as an inhibition of atherosclerosis (hardening of the arteries) progression.[13-15] The administration of synthetic cannabinoids have also been shown to lower blood pressure in animals and have not been associated with cardiotoxicity in humans.[16]

At this time, research assessing the clinical use of cannabinoids for hypertension is in its infancy though further investigation appears warranted.[17]

REFERENCES

[1] Franjo Grotenhermen. 2006. Clinical pharmacodynamics of cannabinoids. In Russo et al (Eds) *Handbook of Cannabis Therapeutics*. Binghamton, New York: Haworth Press.

[2] Batkai et al. 2004. Endocannabinoids acting at cannabinoid-1 receptors regulate cardiovascular function in hypertension. *Circulation* 110: 1996-220.

[3] Pacher et al. 2005. Blood pressure regulation by endocannabinoids and their receptors (PDF). *Neuropharmacology* 48: 1130-1138.

[4] Ibid.

[5] Cecilia Hillard. 2000. Endocannabinoids and vascular function. *Journal of Pharmacology and Experimental Therapeutics*. 294: 27-32.

[6] Kunos et al. 2000. Endocannabinoids as cardiovascular modulators. *Chemistry and Physics of Lipids* 108: 159-168.

[7] Reese Jones. 2002. Cardiovascular system effects of marijuana. *Journal of Clinical Pharmacology*. 42: 58-63.

[8] Ribuot et al. 2005. Cardiac and vascular effects of cannabinoids: toward a therapeutic use? *Annales de Cardiologie et d'Angéiologie (France)* 54: 89-96.

[9] Steven Karch. 2006. Cannabis and cardiotoxicity. *Forensic Science, Medicine, and Pathology*. 2: 13-18.

[10] Ibid.

[11] Rodondi et al. 2006. Marijuana use, diet, body mass index, and cardiovascular risk factors. *American Journal of Cardiology* 98: 478-484.

[12] Reese Jones. 2002. op. cit.

[13] Steffens and Mach. 2006. Towards a therapeutic use of selective CB2 cannabinoid receptor ligands for atherosclerosis. *Future Cardiology* 2: 49-53.

[14] Steffens et al. 2005. Low dose oral cannabinoid therapy reduces progression of atherosclerosis in mice. *Nature* 434: 782-786.

[15] Steffens and Mach. 2006. Cannabinoid receptors in atherosclerosis. *Current Opinion in Lipidology* 17: 519-526 (E-pub ahead of print).

[16] Steven Karch. 2006. op. cit.

[17] Francois Mach. 2006. New anti-inflammatory agents to reduce atherosclerosis. *Archives of Physiology and Biochemistry* 112: 130-137.

Incontinence

Urinary incontinence is defined as a loss of bladder control. Incontinence can result from several biological factors, including weak bladder muscles and inflammation, as well as from nerve damage associated with diseases such as multiple sclerosis (MS) and Parkinson's disease. More than one in ten Americans over age 65 is estimated to suffer from incontinence, particularly women.

Several recent clinical trials indicate that cannabinoid therapy may reduce incidents of incontinence. Writing in the February 2003 issue of the journal *Clinical Rehabilitation*, investigators at Oxford's Centre for Enablement in Britain reported that self-administered doses of whole-plant cannabinoid extracts improved bladder control compared to placebo in patients suffering from MS and spinal cord injury.[1]

Investigators at London's Institute for Neurology followed up these initial findings in an open-label pilot study of cannabis-based extracts for bladder dysfunction in 15 patients with advanced multiple sclerosis. Following cannabinoid therapy, "urinary urgency, the number of and volume of incontinence episodes, frequency and nocturia all decreased significantly," investigators determined. "Cannabis-based medicinal extracts are a safe and effective treatment for urinary and other problems in patients with advanced MS." [2]

These findings were confirmed in 2006 in a multi-center, randomized placebo-controlled trial involving 630 patients administered oral doses of cannabis extracts or THC. Researchers reported that subjects administered cannabis extracts experienced a 38 percent reduction in incontinence episodes from baseline to the end of treatment, while patients administered THC experienced a 33 percent reduction, suggesting a "clinical effect of cannabis on incontinence episodes." [3]

Most recently, preclinical data presented at the 2006 annual meeting of the American Urological Association indicated that cannabis analogs can reduce bladder inflammation and bladder over-activity in animals.[4]

In light of these findings, experts have recommended the use of cannabinoids as potential 'second-line' agents for treating incontinence.[5]

REFERENCES

NORML

Working to Reform Marijuana Laws

- [1] Wade et al. 2003. A preliminary controlled study to determine whether whole-plant cannabis extracts can improve intractable neurogenic symptoms. *Clinical Rehabilitation* 17: 21-29.
- [2] Brady et al. 2004. An open label pilot study of cannabis-based extracts for bladder dysfunction in advanced multiple sclerosis. *Multiple Sclerosis* 10: 425-433.
- [3] Freeman et al. 2006. The effect of cannabis on urge incontinence in patients with multiple sclerosis: a multicentre, randomized placebo-controlled trial. *The International Urogynecology Journal* (E-pub ahead of print).
- [4] University of Pittsburgh Medical Center Press Release. May 21, 2006. "Marijuana-derived drug suppresses bladder pain in animal models."
- [5] Kalsi and Fowler. 2005. Therapy insight: bladder dysfunction associated with multiple sclerosis. *Nature Clinical Practice Neurology* 2: 492-501.

Methicillin-resistant *Staphylococcus aureus* (MRSA)

Many bacterial infections possess multi-drug resistance. Arguably the most significant of these bacteria is methicillin-resistant *Staphylococcus aureus*, more commonly known as MRSA or 'the superbug.' This bacterium is resistant to standard antibiotics, including penicillin. According to the *Journal of the American Medical Association*, MRSA is responsible for nearly 20,000 hospital-stay related deaths annually in the United States.[1]

Published data demonstrates that cannabinoids possess strong antibacterial properties. In 2008, investigators at Italy's Universita del Piemonte Orientale and Britain's University of London, School of Pharmacy assessed the germ-fighting properties of five separate cannabinoids against various strains of multidrug-resistant bacteria, including MRSA. They reported that all of the compounds tested showed "potent antibacterial activity," and that cannabinoids were "exceptional" at halting the spread of MRSA.[2]

A second study published that same year reported that non-cannabinoid constituents in the plant also possess antibacterial properties against MRSA and malaria.[3]

Clinical trials regarding the use of cannabinoids for MRSA have been recommended, with some experts stating, "Cannabis sativa ... represents an interesting source of antibacterial agents to address the problem of multidrug resistance in MRSA and other pathogenic bacteria." [4]

REFERENCES

[1] Klevens et al. 2007. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *Journal of the American Medical Association* 298: 1763-1771.

[2] Appendino et al. 2008. Antibacterial cannabinoids from cannabis sativa: a structure study. *Journal of Natural Products* 71: 1427-1430.

[3] Radwan et al. 2008. Non-cannabinoid constituents from a high potency cannabis sativa variety. *Phytochemistry* 69: 26727-2633.

[4] Appendino et al. 2008. op. cit.

Multiple Sclerosis

Multiple sclerosis (MS) is a chronic degenerative disease of the central nervous system that causes inflammation, muscular weakness, and a loss of motor coordination. Over time, MS patients typically become permanently disabled, and in some cases the disease can be fatal. According to the US National Multiple Sclerosis Society, about 200 people are diagnosed every week with the disease — often striking those 20 to 40 years of age.

Clinical and anecdotal reports of cannabinoids' ability to reduce MS-related symptoms such as pain, spasticity, depression, fatigue, and incontinence are plentiful in the scientific literature[1-12] — leading many MS-associated patient organizations, including the Multiple Sclerosis Societies of Britain and Canada, to take positions in favor of the drug's prescription use.[13] Patients with multiple sclerosis typically report engaging in cannabis therapy[14], with one survey indicating that nearly one in two MS patients use the drug therapeutically.[15]

Recent clinical and preclinical studies also suggest that cannabinoids may inhibit MS progression. Writing in the July 2003 issue of the journal *Brain*, investigators at the University College of London's Institute of Neurology reported that administration of the synthetic cannabinoid agonist WIN 55,212-2 provided "significant neuroprotection" in an animal model of multiple sclerosis. "The results of this study are important because they suggest that in addition to symptom management, ... cannabis may also slow the neurodegenerative processes that ultimately lead to chronic disability in multiple sclerosis and probably other disease," researchers concluded.[16]

Investigators at the Netherland's Vrije University Medical Center, Department of Neurology, also reported for the first time in 2003 that the administration of oral THC can boost immune function in patients with MS. "These results suggest pro-inflammatory disease-modifying potential of cannabinoids [for] MS," they concluded.[17]

Clinical data reported in 2006 from an extended open-label study of 167 multiple sclerosis patients found that use of whole plant cannabinoid extracts relieved symptoms of pain, spasticity, and bladder incontinence for an extended period of treatment (mean duration of study participants was 434 days) without requiring subjects to increase their dose.[18] Results from a separate two-year open label extension trial in 2007 also reported that the administration of cannabis extracts was associated with long-term reductions in neuropathic pain in select MS patients. On average, patients in the study required fewer

daily doses of the drug and reported lower median pain scores the longer they took it. [19] These results would be unlikely in patients suffering from a progressive disease like MS unless the cannabinoid therapy was halting its progression, investigators have suggested.

As a result, the British government is now sponsoring a three-year clinical trial to assess the long-term effects of cannabinoids on both MS-associated symptom management as well as disease progression. Health Canada also recently approved the prescription use of cannabis abstracts for the treatment of MS-associated neuropathic pain.[20] Similar approval of cannabis extracts is pending in Britain and Europe.

REFERENCES

- [1] Chong et al. 2006. Cannabis use in patients with multiple sclerosis. *Multiple Sclerosis* 12: 646-651.
- [2] Rog et al. 2005. Randomized, controlled trial of cannabis-based medicine in central pain in multiple sclerosis. *Neurology* 65: 812-819.
- [3] Wade et al. 2004. Do cannabis-based medicinal extracts have general or specific effects on symptoms in multiple sclerosis? A double-blind, randomized, placebo-controlled study on 160 patients. *Multiple Sclerosis* 10: 434-441.
- [4] Brady et al. 2004. An open-label pilot study of cannabis-based extracts for bladder dysfunction in advanced multiple sclerosis. *Multiple Sclerosis* 10: 425-433.
- [5] Vaney et al. 2004. Efficacy, safety and tolerability of an orally administered cannabis extract in the treatment of spasticity in patients with multiple sclerosis: a randomized, double-blind, placebo-controlled, crossover study. *Multiple Sclerosis* 10: 417-424.
- [6] Zajicek et al. 2003. Cannabinoids for treatment of spasticity and other symptoms related to multiple sclerosis: multicentre randomized placebo-controlled trial [PDF]. *The Lancet* 362: 1517-1526.
- [7] Page et al. 2003. Cannabis use as described by people with multiple sclerosis [PDF]. *Canadian Journal of Neurological Sciences* 30: 201-205.
- [8] Wade et al. 2003. A preliminary controlled study to determine whether whole-plant cannabis extracts can improve intractable neurogenic symptoms. *Clinical Rehabilitation* 17: 21-29.
- [9] Consroe et al. 1997. The perceived effects of smoked cannabis on patients with multiple sclerosis. *European Journal of Neurology* 38: 44-48.
- [10] Meinck et al. 1989. Effects of cannabinoids on spasticity and ataxia in multiple sclerosis. *Journal of Neurology* 236: 120-122.

- [11] Ungerleider et al. 1987. Delta-9-THC in the treatment of spasticity associated with multiple sclerosis. *Advances in Alcohol and Substance Abuse* 7: 39-50.
- [12] Denis Petro. 1980. Marijuana as a therapeutic agent for muscle spasm or spasticity. *Psychosomatics* 21: 81-85.
- [13] See: "Health Organizations' Endorsements," available online.
- [14] Clark et al. 2004. Patterns of cannabis use among patients with multiple sclerosis. *Neurology* 62: 2098-2010.
- [15] Reuters News Wire. August 19, 2002. "Marijuana helps MS patients alleviate pain, spasms."
- [16] Pryce et al. 2003. Cannabinoids inhibit neurodegeneration in models of Multiple Sclerosis. *Brain* 126: 2191-2202.
- [17] Killestein et al. 2003. Immunomodulatory effects of orally administered cannabinoids in multiple sclerosis. *Journal of Neuroimmunology* 137: 140-143.
- [18] Wade et al. 2006. Long-term use of a cannabis-based medicine in the treatment of spasticity and other symptoms of multiple sclerosis. *Multiple Sclerosis* 12: 639-645.
- [19] Rog et al. 2007. Oromucosal delta-9-tetrahydrocannabinol/cannabidiol for neuropathic pain associated with multiple sclerosis: an uncontrolled, open-label, 2-year extension trial. *Clinical Therapeutics* 29: 2068-2079.
- [20] Canada News Wire. June 20, 2005. "Sativex: Novel cannabis derived treatment for MS pain now available in Canada by prescription."

Osteoporosis

Osteoporosis is a degenerative skeletal disease characterized by a deterioration of bone tissue. Patients with osteoporosis are at risk for suffering multiple fractures and other serious disabilities. Approximately 10 million Americans over age 50 suffer from osteoporosis, according to the US Surgeon General's office, and another 34 million are at risk for developing the disease.

Initial references regarding the potential use of cannabinoids to protect against the onset of osteoporosis are available in the scientific literature beginning in the early 1990s.[1] To date, however, no clinical work has taken place investigating the use of cannabis for this indication.

Writing in the January 2006 issue of the *Proceedings of the National Academy of Sciences*, investigators at the Bone Laboratory of the Hebrew University in Jerusalem reported that the administration of the synthetic cannabinoid agonist HU-308 slowed the development of osteoporosis, stimulated bone building, and reduced bone loss in animals.[2] Follow up research published in the *Annals of the New York Academy of Sciences* in 2007 reported that the activation of the CB2 cannabinoid receptor reduced experimentally-induced bone loss and stimulated bone formation.[3] Investigators have previously reported that mice deficient in the CB2 cannabinoid receptor experienced age-accelerated bone loss reminiscent of human osteoporosis.[4]

Though the role of the endocannabinoid system in the regulation of bone mass is not yet well understood,[5] experts are hopeful that cannabinoids and the cannabinoid receptor system may be "A promising target novel target for anti-osteoporotic drug development." [6]

REFERENCES:

[1] Vratislav Schrieber. 1995. Endocrinology 1994-1995. *Casopis Lekarů Ceskych* (Czech Republic) 134: 535-536.

[2] Ofek et al. 2006. Peripheral cannabinoid receptor, CB2, regulates bone mass. *Proceedings of the National Academy of Sciences of the United States of America* 103: 696-701.

[3] Bab Itai. 2007. Regulation of Skeletal Remodeling by the Endocannabinoid System. *Annals of the New York Academy of Sciences* (E-pub ahead of print).

[4] Ofek et al. 2006. op. cit.

NORML

Working to Reform Marijuana Laws

[5] Idris et al. 2005. Regulation of bone mass, bone loss and osteoclast activity by cannabinoid receptors. *Nature Medicine* 11: 774-779.

[6] Bab Itai. 2007. op. cit.

Pruritus

Itching (pruritus) is a common symptom associated with numerous skin diseases, as well as a secondary symptom of numerous serious conditions such as renal failure and liver disease. Itching, unlike other skin sensations, is generally a result of CNS activities, and typically goes untreated by standard medical therapies.

A review of the scientific literature reveals three clinical trials investigating the use of cannabinoids in the treatment of pruritus. Writing in the August 2002 issue of the *American Journal of Gastroenterology*, investigators from the University of Miami Department of Medicine reported successful treatment of pruritus with 5 mg of THC in three patients with cholestatic liver disease.[1] Prior to cannabinoid therapy, subjects had failed to respond to standard medications and had lost their ability to work. Following evening cannabinoid administration, all three patients reported a decrease in pruritus, as well as "marked improvement" in sleep and were eventually able to return to work. Resolution of depression was also reported in two out of three subjects. "Delta-9-tetrahydrocannabinol may be an effective alternative in patients with intractable cholestatic pruritus," investigators concluded.

The following year, British researchers reported in the June 2003 issue of the journal *Inflammation Research* that the peripheral administration of the synthetic cannabinoid agonist HU-211 significantly reduced experimentally-induced itch in 12 subjects.[2] Investigators had previously reported that topical application of HU-210 on human skin reduced experimentally-induced pain and acute burning sensations.[3]

Most recently, researchers at Wroclaw, Poland's University of Medicine, Department of Dermatology, reported that application of an endocannabinoid-based topical cream reduced uremic pruritus and xerosis (abnormal dryness of the skin) in hemodialysis patients.[4] Three weeks of twice-daily application of the cream "completely eliminated" pruritus in 38 percent of trial subjects and "significantly reduced" itching in others. Eighty-one percent of patients reported a "complete reduction" in xerosis following cannabinoid therapy.

In light of these encouraging preliminary results, some dermatology experts now believe that cannabinoids and the cannabinoid system may represent "promising new avenues for managing itch more effectively." [5]

REFERENCES

- [1] Neff et al. 2002. Preliminary observation with dronabinol in patients with intractable pruritus secondary to cholestatic liver disease. *American Journal of Gastroenterology* 97: 2117-2119.
- [2] Dvorak et al. 2003. Histamine induced responses are attenuated by a cannabinoid receptor agonist in human skin (PDF). *Inflammation Research* 25: 238-245.
- [3] Dvorak et al. 2003. Cannabinoid agonists attenuate capsaicin-induced responses in human skin. *Pain* 102: 283-288.
- [4] Szepietowski et al. 2005. Efficacy and tolerance of the cream containing structured physiological lipid endocannabinoids in the treatment of uremic pruritus: a preliminary study. *Acta Dermatovenerologic Croatia (Croatia)* 13: 97-103.
- [5] Paus et al. 2006. Frontiers in pruritus research: scratching the brain for more effective itch therapy. *Journal of Clinical Investigation* 116: 1174-1185.

Rheumatoid Arthritis

Rheumatoid arthritis (RA) is an inflammatory disease of the joints characterized by pain, stiffness, and swelling, as well as an eventual loss of limb function. Rheumatoid arthritis is estimated to affect about one percent of the population, primarily women.

Use of cannabis to treat symptoms of RA is commonly self-reported by patients with the disease. In a 2005 anonymous questionnaire survey of medicinal cannabis patients in Australia, 25 percent reported using cannabinoids to treat RA.[1] A survey of British medicinal cannabis patients found that more than 20 percent of respondents reported using cannabis for symptoms of arthritis.[2] Nevertheless, few clinical trials investigating the use of cannabis for RA appear in the scientific literature.

In January 2006, investigators at the British Royal National Hospital for Rheumatic Disease reported successful treatment of arthritis with cannabinoids in the first-ever controlled trial assessing the efficacy of natural cannabis extracts on RA.[3] Investigators reported that administration of cannabis extracts over a five week period produced statistically significant improvements in pain on movement, pain at rest, quality of sleep, inflammation, and intensity of pain compared to placebo. No serious adverse effects were observed. Similar results had been reported in smaller, Phase II trials investigating the use of orally administered cannabis extracts on symptoms of RA.[4]

Preclinical data also indicates that cannabinoids can moderate the progression of RA. Writing in the August 2000 issue of the *Journal of the Proceedings of the National Academy of Sciences*, investigators at London's Kennedy Institute for Rheumatology reported that cannabidiol (CBD) administration suppressed progression of arthritis *in vitro* and in animals.[5] Administration of CBD after the onset of clinical symptoms protected joints against severe damage and "effectively blocked [the] progression of arthritis," investigators concluded. Daily administration of the synthetic cannabinoid agonist HU-320 has also been reported to protect joints from damage and to ameliorate arthritis in animals.[6]

Summarizing the available literature in the September 2005 issue of the *Journal of Neuroimmunology*, researchers at Tokyo's National Institute for Neuroscience concluded, "Cannabinoid therapy of RA could provide symptomatic relief of joint pain and swelling as well as suppressing joint destruction and disease progression." [7]

REFERENCES

The National Organization for the Reform of Marijuana Laws (www.norml.org)

NORML

Working to Reform Marijuana Laws

- [1] Swift et al. 2005. Survey of Australians using cannabis for medical purposes. *Harm Reduction Journal* 4: 2-18.
- [2] Ware et al. 2005. The medicinal use of cannabis in the UK: results of a nationwide survey. *International Journal of Clinical Practice* 59: 291-295.
- [3] Blake et al. 2006. Preliminary assessment of the efficacy, tolerability and safety of a cannabis medicine (Sativex) in the treatment of pain caused by rheumatoid arthritis. *Rheumatology* 45: 50-52.
- [4] No author. 2003. Cannabis-based medicines. *Drugs in Research and Development* 4: 306-309.
- [5] Malfait et al. 2000. The nonpsychoactive cannabis constituents cannabidiol is an oral anti-arthritic therapeutic in murine. *Journal of the Proceedings of the National Academy of Sciences* 97: 9561-9566.
- [6] Sumariwalla et al. 2004. A novel synthetic, nonpsychoactive cannabinoid acid (HU-320) with anti-inflammatory properties in murine collagen-induced arthritis. *Arthritis & Rheumatism* 50: 985-998.
- [7] Croxford and Yamamura. 2005. Cannabinoids and the immune system: Potential for the treatment of inflammatory diseases. *Journal of Neuroimmunology* 166: 3-18.

Sleep Apnea

Sleep apnea is a medical disorder characterized by frequent interruptions in breathing of up to ten seconds or more during sleep. The condition is associated with numerous physiological disorders, including fatigue, headaches, high blood pressure, irregular heartbeat, heart attack and stroke. Though sleep apnea often goes undiagnosed, it is estimated that approximately four percent of men and two percent of women ages 30 to 60 years old suffer from the disease.

One preclinical study is cited in the scientific literature investigating the role of cannabinoids on sleep-related apnea. Writing in the June 2002 issue of the journal of the American Academy of Sleep Medicine, researchers at the University of Illinois (at Chicago) Department of Medicine reported "potent suppression" of sleep-related apnea in rats administered either exogenous or endogenous cannabinoids.[1] Investigators reported that doses of delta-9-THC and the endocannabinoid oleamide each stabilized respiration during sleep, and blocked serotonin-induced exacerbation of sleep apnea in a statistically significant manner. No follow up investigations have taken place assessing the use of cannabinoids to treat this indication. However, several recent preclinical and clinical trials have reported on the use of THC, natural cannabis extracts, and endocannabinoids to induce sleep[2,3] and/or improve sleep quality.[4]

REFERENCES

- [1] Carley et al. 2002. Functional role for cannabinoids in respiratory stability during sleep. *Sleep* 25: 399-400.
- [2] Murillo-Rodriguez et al. 2003. Anandamide enhances extracellular levels of adenosine and induces sleep: an in vivo microdialysis study. *Sleep* 26: 943-947.
- [3] Nicholson et al. 2004. Effect of delta-9-tetrahydrocannabinol and cannabidiol on nocturnal sleep and early-morning behavior in young adults. *Journal of Clinical Pharmacology* 24: 305-313.
- [4] Christine Perras. 2005. Sativex for the management of multiple sclerosis symptoms. *Issues in Emerging Health Technologies* 72: 1-4

Tourette's Syndrome

Tourette's syndrome (TS) is a complex neuropsychiatric disorder of unknown etiology that is characterized by involuntary vocal tics. Severity of this condition varies widely among patients. Though there is no cure for Tourette's syndrome, the condition often improves with age. Experts estimate that 100,000 Americans are afflicted with TS.

A review of the scientific literature reveals several clinical trials investigating the use of cannabinoids for the treatment of TS. Writing in the March 1999 issue of the *American Journal of Psychiatry*, investigators at Germany's Medical School of Hanover, Department of Clinical Psychiatry and Psychotherapy, reported successful treatment of Tourette's syndrome with a single dose of 10 mg of delta-9-THC in a 25-year-old male patient in an uncontrolled open clinical trial.[1] Investigators reported that the subject's total tic severity score fell from 41 to 7 within two hours following cannabinoid therapy, and that improvement was observed for a total of seven hours. "For the first time, patients' subjective experiences when smoking marijuana were confirmed by using a valid and reliable rating scale," authors concluded.

Investigators again confirmed these preliminary results in a randomized double-blind placebo-controlled crossover single dose trial of THC in 12 adult TS patients. Researchers reported a "significant improvement of tics and obsessive-compulsive behavior (OCB) after treatment with delta-9-THC compared to placebo." [2] Investigators reported no cognitive impairment in subjects following THC administration [3] and concluded, "THC is effective and safe in treating tics and OCB in TS." [4]

Investigators confirmed these results in a second randomized double-blind placebo-controlled trial involving 24 patients administered daily doses of up to 10 mg of THC over a six-week period. Researchers reported that subjects experienced a significant reduction in tics following long-term cannabinoid treatment, [5] and suffered no detrimental effects on learning, recall or verbal memory. [6] A trend toward significant improvement of verbal memory span during and after therapy was also observed.

Summarizing their findings in the October 2003 issue of the journal *Expert Opinions in Pharmacotherapy*, investigators concluded that in adult TS patients, "Therapy with delta-9-THC should be tried ... if well established drugs either fail to improve tics or cause significant adverse effects." [7]

REFERENCES

- [1] Muller-Vahl et al. 1999. Treatment of Tourette's syndrome with delta-9-tetrahydrocannabinol. *American Journal of Psychiatry* 156: 495.
- [2] Muller-Vahl et al. 2002. Treatment of Tourette's syndrome with Delta-9-tetrahydrocannabinol (THC): a randomized crossover trial. *Pharmacopsychiatry* 35: 57-61.
- [3] Muller-Vahl et al. 2001. Influence of treatment of Tourette syndrome with delta9-tetrahydrocannabinol (delta9-THC) on neuropsychological performance. *Pharmacopsychiatry* 34: 19-24.
- [4] Muller-Vahl et al. 2002. op. cit.
- [5] Muller-Vahl et al. 2003. Delta 9-tetrahydrocannabinol (THC) is effective in the treatment of tics in Tourette syndrome: a 6-week randomized trial. *Journal of Clinical Psychiatry* 64: 459-65.
- [6] Muller-Vahl et al. 2003. Treatment of Tourette syndrome with delta-9-tetrahydrocannabinol (delta 9-THC): no influence on neuropsychological performance. *Neuropsychopharmacology* 28: 384-8.
- [7] Kirsten Muller-Vahl. 2003. Cannabinoids reduce symptoms of Tourette's syndrome. *Expert Opinions in Pharmacotherapy* 4: 1717-25.