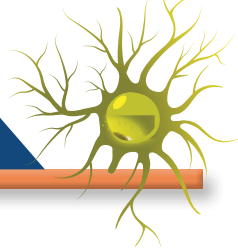

Marijuana: Neurological friend or foe?

The increased recreational use of marijuana has reignited a long-standing debate on its relative health benefits and dangers. As of the writing of this article, 29 states and the District of Columbia have legalized or decriminalized the use of marijuana for recreational or medical purposes. Many professional health care associations applaud the trend to decriminalize marijuana use, but they continue to warn about the risks of dependency, addiction and long-term neurological impairment associated with adolescent use. Regardless, with today's state government approval, growing positive media coverage and increasing medical application, the idea that marijuana must be safe and harmless seems to have permeated the cultural psyche.

What is the truth about marijuana and its neurological consequences? Is it friend or foe? How might clinicians work with clients who present with recreational or medical marijuana use? The purpose of this article is to explore these questions and to offer some neurologically based direction for those struggling with the consequences of today's marijuana renaissance.

Brief history of marijuana

Marijuana, or cannabis, and the growing of hemp (the plant fiber) for paper, cloth and rope have been around for centuries. Use of hemp as a fabric has been traced to 8000-7000 B.C. Uses for medical purposes were recorded as early as 2700 B.C. by Shen Nung, one of the fathers of Chinese medicine. Many cultures viewed hemp as a gift from a divine spirit. It was used in ceremonial garb, as incense, for meditation, for enhanced awareness and for pleasure.

Early American colonists were urged to cultivate hemp for paper and cloth as an American trade product. In 1914, to stem the growing use and addictive consequences of cocaine in common health remedies, the U.S. government defined drug use as a crime. In 1937, marijuana was taxed and its nonmedical use outlawed on the national level. In the 1950s, mandatory sentencing was imposed for drug offenses, but by the 1970s, enforcement of these laws was eased. Then in 1996, California became the first state to legalize the use of medical marijuana. Since that time, the trend toward decriminalization and medical and recreational use of marijuana has continued.

Active ingredients and use

The primary active ingredients in marijuana are delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD). THC binds to the brain's cannabinoid receptors and is responsible for the subsequent psychoactive euphoria or high. For some people, this can lead to problems with dependency and addiction. These receptors are part of the endocannabinoid system in the brain, and they influence appetite, pain sensation, mood and memory. They can also alter motor control, coordination and judgment, which can in turn contribute to unintentional death or injury, such as in motor vehicle accidents.

CBD, the most common cannabinoid, does not bind to these receptors and lacks noticeable psychoactive effects. The most frequent pharmaceutical applications for CBD include use in anti-inflammatory, anti-anxiety, anti-epileptic, sedative and antipsychotic agents. CBD also has neuroprotective properties for some cancers, diabetes, rheumatoid arthritis, brain or nerve damage caused by stroke, alcoholism and Huntington's disease.

The primary problem with today's marijuana promotion and use is that the consumer typically assumes that over-the-counter whole marijuana possesses all of the beneficial qualities and none of the risks associated with psychoactive THC. Furthermore, the purity, dose and formulation are not controlled, so the expected positive and negative effects of its use are truly unknown. In addition, although the direct sale of marijuana to minors is prohibited, marijuana use among teenagers is increasing.

The research on long-term, heavy marijuana use is very concerning. It has been associated with an array of psychological, emotional, cognitive and physical problems, including decreased educational achievement, decreased appetite and quality of diet, poorer lung health, sleep difficulty, strange and unusual dreaming, restlessness, nervousness, increased irritability, decreased satisfaction with self and life, decreased happiness and decreased income.

The Food and Drug Administration currently approves THC for medical use in a nonsmoked form for HIV, cancer, chronic pain and multiple sclerosis. It has been found to reduce the nausea, anorexia, stomach upset and anxiety experienced by HIV patients. THC also counteracts the side effects of chemotherapy by decreasing nausea and increasing appetite in cancer patients. In addition, THC has been used to reduce (by as much as 30 percent) otherwise difficult-to-treat neuropathic pain from a variety of causes, including injury, HIV drugs and diabetes. THC has also been found to significantly reduce muscle spasticity associated with multiple sclerosis. Clearly, marijuana has several beneficial effects for those struggling with these debilitating medical conditions.

Caution for teenage consumption

On the other hand, some factors associated with marijuana use warrant both legal prohibition and medical warning. Starting marijuana use before age 17 has been found to decrease overall brain volume and cortical gray matter and increase cerebral blood flow and white matter volume. In addition, both males and females who started marijuana use before age 17 were physically smaller in body height and weight. Males were especially affected, showing delay in the development of secondary sexual characteristics. Early cannabis use has also been linked to lasting consequences on cognition, episodic memory and IQ, with a loss of up to eight IQ points not recovered in adulthood.

Furthermore, heterosexual men between the ages of 18 and 28 who engage in chronic intensive use have decreased testosterone levels and experience significant changes in normal male reproductive physiology. More specifically, research on the effects of THC (for both males and females) on the neuroendocrine regulation of hormone secretion has found inhibition in the production of gonadotropin, prolactin, growth hormone and thyroid-stimulating hormone, and an increase in the release of corticotropin. These effects negatively impact the functioning of the reproductive system, lactation, metabolism and the endocrine stress axis.

Puberty presents a highly vulnerable period for both neurological and physiological maturation. Marijuana use has been found to disrupt this vital process, derailing the essential reorganization of neuronal structures. Without normal developmentally driven neuronal pruning and consolidation, cognitive, emotional, physical and hormonal maturation are inhibited, delayed and, in some aspects, permanently disrupted. These results may increase the risks of future neuropsychiatric disorders, illegal drug use and marijuana dependence.

Potential positive benefits

Research on the possible benefits of marijuana is continually expanding. Researchers have found that marijuana decreases the effects of eye pressure caused by glaucoma, slows its progression and thereby aids in the prevention of blindness. Continual use has been found to expand lung capacity, perhaps because of repeated deep inhalation of smoked marijuana. Marijuana's ability to bind to the brain cells related to excitability and relaxation have resulted in decreases of epileptic seizures. In low doses, it has been found to decrease anxiety and increase mood and associational and creative thought. However, in high doses, marijuana increases anxiety and feelings of paranoia and can trigger psychotic states. Marijuana has also been found to "turn off" a gene implicated in the spread of cancer and is commonly known to decrease pain and nausea and increase the appetite in those undergoing chemotherapy.

In addition, marijuana has been found to help manage the effects of Crohn's disease, an inflammatory bowel disorder, by causing the cells of the intestine wall to bond tighter together, thus decreasing the permeability of the intestines and blocking bacterial entry. Marijuana also counteracts the side effects of hepatitis C by decreasing fatigue, nausea, muscle ache, appetite loss and depression. Cannabis has also been used to decrease pain and disrupted sleep associated with the discomfort of arthritis.

Researchers studying lupus have found that marijuana calms the immune system and decreases the pain and nausea that frequently accompany the autoimmune disorder. Research on posttraumatic stress disorder (PTSD) showed that marijuana has a calming effect on the body and the brain, helping to regulate the fear and anxiety generated by limbic area overactivation. In addition, marijuana has been found to eliminate the nightmares associated with PTSD by disrupting the deeper stages of the sleep cycle. This, however, may have longer-term negative consequences because of the lost benefits of deep recovery sleep.

A less-appreciated consequence of marijuana use is the disruption of the brain's reward system. This is the process that leads to dependency.

Still other researchers have noted marijuana's relatively reduced adverse impact as a "harm reduction strategy," citing the potential decrease in the physiological effects of long-term alcohol abuse. Although acute intake of marijuana has been found to stimulate the hypothalamus and cause an increased sense of enjoyment and appetite, regular use has been associated with weight loss due to increased metabolism.

Finally, the neuroprotective potential of marijuana has been studied in THC's ability to inhibit the formation of amyloid plaques and slow the progression of Alzheimer's disease. THC has also been shown to bind to the nerve receptors and decrease the spasms and pain associated with multiple sclerosis. Furthermore, it has been found to smooth the tremors, reduce the pain and improve the fine motor skills of those with Parkinson's disease. Perhaps even more intriguing, research has demonstrated that marijuana can reduce the size of the area affected by a stroke and reduce bruising and facilitate neuronal healing after a concussion or traumatic brain injury.

Potential negative consequences

Common acute negative consequences of marijuana use include an initially increased heart rate of 20 to 50 beats per minute that eventually calms down, red eyes due to the expansion of ocular blood vessels, dry mouth due to decreased saliva production and the "munchies" due to stimulation of the hypothalamus. Other acute consequences include problems with judgment, balance, posture and coordination due to the effects of cannabis on the frontal cortex, cerebellum and basal ganglia. This is what makes the operation of a motorized vehicle under the influence of marijuana a very dangerous endeavor.

A lesser-known negative consequence is blocked memory formation due to marijuana's impact on the hippocampus. In teenagers, this can lead to long-term cognitive deficits. In adults, it can lead to quickening of age-related brain cell loss.

Still another less-appreciated consequence of marijuana use is the disruption of the brain's reward system. This is the process that leads to dependency. The initial surge of dopamine and its resulting euphoria eventually wane as the brain becomes overstimulated. With chronic use, interest in the enjoyment and stimulation from normal activities is decreased and amotivational syndrome dominates, creating lethargy and further decreasing the brain's ability to enjoy normal sources of satisfaction and motivation.

As previously mentioned, sleep quality is also affected, with the brain losing its ability to reach deeper levels of REM sleep. This impacts nightly physiological and neurological recovery via glial cells that rid the brain of unwanted toxins and damaged neuronal material. It also inhibits memory consolidation and disrupts the psychoemotional healing provided by deep-sleep dream states.

Other psychoemotional consequences of ongoing marijuana use include increased depression for those with a genetic predisposition to depression; increased anxiety, distrust, panic and paranoia for about 20 to 30 percent of ongoing users; and increased risk of schizoaffective disorder and psychosis that includes delusions, hallucinations, loss of identity and a phenomenon called "looping sounds" that involves repeated auditory echoing.

Neurological effects

Daniel Amen, a psychiatrist and neurologist who has collected a library of SPECT (single-photon emission computed tomography) scan images of the brain functioning of long-term marijuana users, has concluded that "marijuana is toxic to the brain." He asserts that it decreases overall brain activity and cerebral blood flow and causes problems with attention, focus, planning, impulse control and motivation. He has also noted slowed neurological activity in the frontal-temporal areas of the brain that affect executive function, memory, learning and mood stability. The functions of the prefrontal cortex involve focus, planning, impulse control, making good or bad decisions, attention span, organization and follow-through. The functions of the temporal lobes include memory, learning, motivation (or amotivational syndrome), and involvement and engagement (or apathy, lethargy, social withdrawal and loss of interest in activity).

Amen emphasizes that marijuana is not selective in its impact on the brain. Although it does calm areas that are overreactive, such as in problems with anxiety and trauma, it does this by calming the entire brain, including essential areas that are necessary for healthy functioning. He has concluded that marijuana is addictive and rewires the brain's pleasure centers, intensifying a craving for the drug. When ceasing use, intense irritability emerges as the temporal lobes begin to regain normal function. In two to three months, SPECT scan improvements can be observed in brain areas responsible for motivation, concentration and focus.

As previously noted, brain tissue changes have also been identified in ongoing marijuana use. The density of gray brain matter is related to the function of the neuronal cell bodies within that particular area. The density of white brain matter is related to the connectedness or communication of neurons with one another in that area or tracts of neurons across areas. The changes observed related to marijuana use include:

- Lower gray matter density in the right parahippocampal gyrus (affecting memory)
- High gray matter density in the precentral gyrus (affecting voluntary movement) and right thalamus (affecting sensory perception)
- Low white matter density in the left parietal lobe (affecting sensory processing)
- High white matter density in the parahippocampal (affecting memory) and fusiform gyri (affecting recognition of faces and expert objects) and left precentral gyrus (affecting movement)

Finally, the effect of marijuana on the brain's electrical activity also confirms its impact on the frontal lobes, thereby disrupting executive functioning, memory, emotional awareness and emotional regulation. The primary impact is the creation of what is called "alpha hyperfrontality."

The alpha brain wave is generally understood as involving a state of "calm focus" and is defined as occurring within a range of 8 to 12 hertz (cycles per second) of electrical activity. The lower end of this range is associated with cognitive inefficiency, whereas the higher end is associated with cognitive efficiency; the middle (10 hertz) serves as the point of optimal balance and functioning. With ongoing marijuana use, the optimal alpha wave slides to the lower end and dominates the frontal cortex. This creates a state of neurological function akin to attention-deficit disorder and early onset dementia. This not only impairs the functions associated with the frontal cortex but also affects the many neurological networks that interact with it, such as motivation, emotional response, physiological activation and cognitive functioning.

A second effect of marijuana use on the brain's electrical activity involves a decrease in the gamma waves (40 hertz). Gamma waves are involved in the experience of insight, satisfaction and happiness, which aid in the consolidation of learning. Of course, the duration (age of commencement and years of continued use), dose and frequency of marijuana use combine to determine the severity of its consequences.

Finally, it is important to note that the neurological consequences of marijuana use, dependency and addiction can be significantly reversed with a combination of traditional substance abuse treatment and neurofeedback. Outcome studies have found a reduction in relapse rates from 80 percent for 12-step programs alone to 20 percent for combined approaches.

Clinical implications

1) Comprehensive assessment of marijuana use is essential in the diagnosis, treatment plan formulation and treatment of all presenting problems.

2) Adolescents and young adults up to age 28 should be strongly discouraged and, where possible, prohibited from any marijuana use unless medically recommended.

3) The positive benefits of marijuana use for those struggling with a debilitating medical or mental health condition must be carefully weighed against its negative consequences. Individuals are best advised to first exhaust all other treatments that are less risk inherent.

4) Client education concerning the risks of even recreational marijuana use and its neurological, cognitive, motivational, emotional and developmental consequences should be promoted.

5) The most effective treatment for marijuana dependency and addiction must address its behavioral, physiological, emotional, interpersonal and neurological consequences. Currently, the most comprehensive treatment approach combines a 12-step-oriented program with neurofeedback.

6) Counselors need to continue to advocate for treatment assistance and decriminalization of marijuana offenses. ❖

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