The impact of prolonged methamphetamine abuse.

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Abstract

Over the years methamphetamine abuse has plagued the American judicial system, our health care system, and communities both big and small. With such proliferated abuse comes an invasion of poverty, crime, addiction, prostitution, venereal diseases, and death. Furthermore, research indicates that 34.9% of admitted meth users "had committed violence while under the influence of methamphetamine" [1]. Statistics such as these raise concern for our youth, and for the future of our communities. However, in order to properly understand the reasoning for such behaviour, we must first begin to outline the neurological impact methamphetamine has on its users over an extended period of time. Therefore, this paper examines the neurological alterations/impact which is the result of prolonged methamphetamine abuse.

Keywords: Methamphetamine abuse, neurological effects, physical effects, rehabilitation.

Abbreviations: Meth: Methamphetamine, Detox: Detoxification.

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Introduction

The perilous impact methamphetamine abuse has on users, families, and society alike has perplexed treatment providers, law enforcement agencies, and many others for years. The chronic nature and deviational impact associated with methamphetamine addiction is one of unspoken bounds and is responsible for the taking the lives of countless individuals. Many do not understand why this substance is so addictive, which makes it difficult when encountering this disease. According to data collected by the Drug Abuse Warning network, Methamphetamine (meth) use among short-stay hospital patients more than tripled from 1991 to 1994. Furthermore, methamphetamine-related deaths tripled during this time period, while there was a 43 percent increase in treatment-program admissions among meth abusing clients [2]. Findings such as this not only highlight the growing popularity of meth use, but it forces practitioners and researchers alike to begin to understand the neurological impact such abuse has on its users. By gaining such an understanding, we can hopefully discover new forms of treatment and better ways to save our communities and its residents.

Effect of methamphetamine on brain

Research suggests that: the personality centers in the midbrain are vulnerable to the toxic effects of all addictive drugs, particularly methamphetamine. These structures include the self-control tract (fasciculus retroflexus, ventral tegmental area), the pleasure centre (nucleus accumbens), motivational and motor centers (striatum), centers for emotional control (amygdala), appetite and sleep cycle (reticular activating system), judgment and cognitive processes (frontal lobes), and memory (hippocampus) [3]. When you combined all of these cognitive structures along with the neurochemical influence meth has, you can begin to realize why it creates such hardships for its users and the surrounding community. Methamphetamine is a unique substance in several aspects. To begin with, meth is not a natural substance, but rather it is man-made, which can be smoked, injected, or snorted. Although technically classified as a stimulant, meth is entirely distinct from other stimulants such as cocaine. While the effects of cocaine may last for one to two hours (depending on the user's level of tolerance and the purity of the cocaine), whereas equal doses of meth may last for as long as 16 to 20 hours, thus becoming more attractive to its users. It is estimated, that on average, the effects of methamphetamine are "usually 8 to 10 times the duration of equal doses of cocaine" [4]. This long-lasting effect creates several difficulties for habitual users. Methamphetamine is unique from other stimulants in additional ways as well. To begin, meth has an entirely different impact on neurotransmitters within the brain. Typical stimulants, such as cocaine, tend to trigger the release of dopamine, serotonin, and epinephrine, while blocking the reuptake of these neurotransmitters and ultimately increasing their activity within the brain. Whereas, meth is distinct in the sense that it may release dopamine, serotonin, and epinephrine; however, it also causes the release of norepinephrine, which accounts for its long-lasting effects on the user. Once meth enters the bloodstream it immediately penetrates presynaptic neurons within the brain causing them to leak neurotransmitters into the cytoplasm of the cell. This in turn affects the outer membrane of the presynaptic neuron and "causes the neurotransmitters to leak uncontrollably into the synaptic gap;" Controlled Substances which dismantles the reuptake process and causes enzymes to break down [4]. Research suggests that because methamphetamine triggers the release of dopamine, serotonin, epinephrine, and norepinephrine, it causes its users to feel a surge of energy, confidence, and an overall sense of euphoria. This creates a feedback loop in which the user pursues these feelings through repeated use of the substance. However, over time this alters the pleasure center in the user's brain, thus making it increasingly difficult for them to feel joy, happiness, or contentment without being under the influence of

methamphetamine. From a scientific standpoint this alteration essentially destroys the "wiring" of the brain's pleasure centers, making it impossible for its users to experience any pleasure at all. Because of this, many meth users enter a state of deep depression, which does not dissipate over time. Abusers may feel that the only way this can be avoided is from the continual usage of methamphetamines or other drugs. Scientific studies revealed that the brain's depletion of dopamine is due to decreases in striatal metabolism, and further damage to the nucleus accumbens, which cause detoxified meth users to experience persistent a motivation and anhedonia [5]. This perpetuating sense of anhedonia leads to increased rates of suicide and a ripple effect of despondency. Additional studies have concluded that chronic meth use increases cytokines in the brain, which in turn guide cells to produce new synapses with existing neurons. This causes additional alterations in one's brain structure and is believed to be a major reason relapse occurs so frequently, even after years of sobriety have been obtained [6]. Brandon Marshall hypothesized that compared to other drug users, it is possible that methamphetamine users are more isolated and have poor social support systems [7]. Furthermore, the destruction of dopamine and serotonin receptors in the midbrain, forces the user to ingest more and more meth to get high. Overtime, many users tend to create "cocktails" of combined drugs, (such as using heroin and meth simultaneously) in an attempt to obtain a high similar to what they experienced with their first use. Aside from the destruction of the brain's pleasure center and long-term alteration in one's brain chemistry, repeated meth use also leads to higher transmission rates of HIV, severe weight loss, violent behaviours, tooth decay, body sores, and accelerated aging. Because meth is frequently injected, users tend to share needles. This also leads its users to engage in unsafe sexual practices, which combined with intravenous administration, create a skyrocketing risk for HIV infection. In New York alone, there has been an average of 1,000 new HIV-positive cases per year [8]. Several studies have indicated that meth users who contract the HIV virus have greater neuronal loss and cognitive impairment than non-meth users who are HIV-positive, which in turn raises the risk of suicide and a hastened death [9].

Due to the neuro-toxic chemicals in which meth is manufactured from, coupled with its biochemical effect on neurotransmitters within the brain, repeated and prolonged use typically creates irreversible cell damage from essentially poisoning neurons in the brain, and ultimately altering one's brain chemistry. According to Armstrong and Noguchi [10], repeated methamphetamine use damages cellular transports while destroying receptors within the brain. However, their research also indicated that these biochemical changes can be reversible in some users following a long detoxification process, which typically lasts from weeks to months. Meanwhile, additional research conducted on chronic meth abusers who had one year of abstinence revealed no improvements in cognitive abilities In fact, this study concluded that these former users continued to display severe impairments in memory, judgment, and motor coordination after 14 months of recovery, thus suggesting irreversible brain damage [5]. Perhaps the irreversible alterations in one's brain structure accounts for the criminal presentation and deviate behaviour which is often observed its users. Therefore, research appears to be inconclusive on the true severity of long-term and possible irreversibility of neuronal damage caused by chronic meth use. However, it is known that meth use creates numerous alterations within the brain, thus making it increasingly difficult for its users to remain abstinent while returning to a previous level of functioning. Researchers examined brain cell death within meth users and discovered that the frontal lobes, caudate nucleus, and hippocampus appear to be the areas that suffer the most prolonged and irreversible damage [11]. Their research also revealed that cell death in the self-control tract and the reward centers of the brain is quite rampant. Damage such as this mirrors the development of schizophrenia and dementia in the user, and frequently creates psychosis in advanced users. This psychosis appears to be irreversible, although "not necessarily untreatable" [3].

Psychosis occurs due to the adrenaline rush experienced by its user. This creates a propensity for repeated psychotic episodes, which does not diminish over time. Sustained serotonin release is primarily responsible for psychotic symptoms such as hallucinations or delusions, which leads meth abusers to become paranoid and anxious. When this occurs chronic meth users typically display bouts of aggression and irritability. Meanwhile, the intense release of dopamine creates feelings of pleasure; however, this can also make its user feel jittery or restless. When you combined this with the epinephrine and norepinephrine release which causes the user to feel increased energy, they often go days without sleep, while frequently displaying hyperkinetic behaviours [4].

Furthermore, recent research has discovered that methamphetamine tends to affect dopamine activity in the prefrontal cortex, while causing excessive damage to the frontal lobes and impairing one's executive functioning behaviors [4]. Meth also damages the parietal lobes, including sensory and motor neurons. This in turn disrupts serotonergic activity and damages the hippocampus on both the right and left temporal lobes which results in both short and long-term memory deficits. Such memory deficits appear to be withstanding, even after a considerable amount of time remaining abstinent from the substance. As previously indicated, meth use damages the cells of the self-control tract (fasciculus retroflexus, ventral tegmental area) of the brain. However, unlike alcohol abuse, which may require years of repeated use to produce damage, meth use can damage the self-control tract upon initial exposure to the substance. This is why many users report experiencing addiction after their first use. Damage to the self-control tract precipitates strong urges, cravings, and impulses to use meth again. Furthermore, by damaging these areas of the brain, meth users find it nearly impossible to resist the temptation to use meth when presented with the opportunity [12]. Damage to this area also propagates "triggers" to use. Therefore, stimuli as simple as a former girlfriend, a piece of tin foil, or places where using took place can create a significant urge to use. Another interesting aspect of methamphetamine is how it affects the body, particularly one's appearance. As indicated before, meth use causes age acceleration and a change in physical appearance, which is actually the result of diminished sleep, nutritional neglect, and poor blood flow throughout the body. Once meth enters the blood stream it causes a rise in body temperature,

rapid heart rate, and immediate blood vessel constriction. This constricting of the blood vessels causes an unsteady flow of blood throughout the body and has a detrimental impact on the user. When this persists for extended periods of time, the blood vessels are eventually destroyed and the body loses its ability to repair itself [8]. Acne and sores eventually appear throughout the user's body, which now take longer to heal; meanwhile the skin begins to lose its radiance and elasticity. Heavy meth users will often end up covered with sores as a result of obsessive skin-picking from experiencing hallucinations of bugs crawling on under their skin, a common phenomenon amongst meth abusers known as "formication." Meth abuse also diminishes salivation in its users. For chronic users, this lack of salivation leads to rapid tooth decay. Such decay is often referred to as "meth mouth" and creates an appearance of blackened, stained, or rotting teeth. Additional factors contribute to meth mouth besides lack of salivation. The chemicals (anhydrous ammonia, red phosphorous, lithium, etc.) often used in the manufacturing of meth can be corrosive to the teeth, and when smoked or snorted, they cause immediate enamel eroding. When you combined this with the body's restricted blood vessels, it is nearly impossible for the user's mouth to stay healthy. Due to the long lasting and intense high meth creates, users typically experience what is known as a "crash." This occurs when the brain stops producing dopamine in order to compensate for the over active release of dopamine while the user was under the influence. Once this occurs, the user begins to experience severe depression, which may persist for months or even years [13]. The user will typically sleep maybe even for several days due to the restlessness they experienced while under the influence. This creates a cycle of abuse, making it increasingly difficult for meth abusers to quit using, and leads to suicidal and violent tendencies [14]. Along with depleted dopamine, meth "crashes" typically evokes extreme aggressive and unpredictable behaviours from the user. Friends and family members will report personality changes in the user, who frequently continues to become overwhelmingly anxious, paranoid, and panicky as they come down from using. At this point, the user begins to experience sobriety and symptoms continue to worsen. This is when many users turn to crime, such as shoplifting, prostitution, or robbery in hopes to obtain money or goods in which to purchase more meth. Users going through meth withdrawal often experience headaches, fits of rage, insomnia, and even psychosis. It is estimated that meth users are responsible for over 60 percent of auto thefts, 70 percent of identity theft, and 90 percent of mail theft [15]. This crime not only hurts the victim and the user, but society as a whole also suffers. To strengthen this notion, a study conducted by the University of Arkansas found that meth use cost one county alone $20 million [15].

During the initial phases of meth use, users typically experience a mild depression after sustaining from meth. However, as their usage worsens, so does the "crash" the user experiences. These will typically extend for longer period of time as abuse continues, and creates urges to continue using meth in order to feel "normal." For heavy users, a crash can last anywhere from seven to fourteen days [3]. Heavy meth users typically dread the inevitable crash, which reinforces their urge to use, thus creating increased irrationality. When users begin to experience sobriety, family members and significant others will continue to report long-term personality changes in the user. They may report the user losing their sense of humor, or wittiness; which is a direct result of the cognitive changes and neurological impairments that are derived from meth use. Meth abuse will typically encompass every aspect of the user's life, including their interpersonal relationships, their ability to maintain employment, financial stability, decision making, and moral reasoning. Meth users begin to isolate themselves from others who do not use; while frequently becoming so preoccupied with their addiction they neglect their children, often to the point Child Protective Services gets involved. Users may stay awake and remain inside their home for days on end. They may begin to repeatedly take things inside their home apart and put them back together, or rearrange their furniture numerous times, or excessively clean their home. Such repeated behaviours are commonly seen and serve to separate the user from normal society. Symptoms of paranoia also keep the user from leaving their home. Paranoid users often believe others are watching them, or that there people in the trees. When facing meth users are faced with many different challenges which are often distinct from other forms of drug use (cocaine, heroin, alcohol use, etc.). Once someone who is addicted to meth decides to abstain from using, it could easily take six to twelve months before the biochemical changes in the brain begin to reverse them self [16]. At this point, depression, anxiety, and mood begin to stabilize. Users may notice a decrease in nightmares along with improved sleep patterns. However, low frustration tolerance and increased irritability continues to persist for several weeks or even months into the recovery process. Most meth users require pharmaceutical intervention, including neuroleptic medications to reduce hallucinations, stabilize mood, and improve sleep cycles. These prolonged changes are the result of "structural damage to the cingulate gyrus and frontal lobes, in general-the same areas affected in endogenous paranoid schizophrenia" [3]. In general, the severity of one's meth use will predetermine their level of recovery, with heavy users facing more difficult hardships than their counterparts. Since meth use destroys neurons in the brain and alters overall functioning, a prolonged period of abstinence is necessary for neuronal repair to occur. However, for most users this typically requires significant psychiatric care, counselling, and social support, which may be necessary for several years following recovery. Even after long term abstinence has been achieved, users may continue to experience memory loss, speech difficulties, irritability, and attention deficits [17]. These symptoms are also frequently accompanied by persistent depression, anhedonia, and noted personality changes by family members. Heavy meth users may require pharmaceutical intervention for the remainder of their life to help combat psychotic symptoms, and many will meet the diagnostic criteria for schizophrenia due to their pathological presentation. For repeated users entering treatment, it is imperative that a thorough risk assessment be conducted on a continual basis to ensure the user's safety [18].

Conclusion

Methamphetamine abuse has an insidious impact on its user's life as well as society. Chronic meth users are initially lured in by the long-lasting impact of the drug, and its influence on the

libido and sense of wellbeing. However, this feeling is quickly diminished due to the intense release of dopamine and serotonin in the brain. Over time, this creates a cycle of intense meth use, followed by extreme depression. And because meth is made from toxic substances, it creates long-term and irreversible damage to several parts of the brain. Detoxified meth users continue to display impairments in memory, motor movement, attention, and judgment, along with psychotic symptoms most commonly seen in schizophrenia. When you combined all of these factors you have a plethora of problems many of which are the direct result of the neurological effects the meth use had on the user's brain structure and chemistry.

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