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Week of November 6, 2017 – The Science of Addiction

A few months ago the cover of National Geographic Magazine caught my eye. The feature article was titled, “The Science of Addiction.” The subtitle was “How new discoveries about the brain can help us kick the habit.” While this topic may appear to be a little off the main stream of occupational safety and health, I thought the subject to be pertinent as opioid addiction is getting substantial coverage these days. At the same time, the use of such substances has the potential to effect so many of us in the workplace as operating heavy equipment and even driving vehicles on a work site can result in serious incidents due to persons being under-the-influence.

Addiction is a chronic disease characterized by a compulsive pursuit for a substance to a point that is compulsive, or difficult to control- despite harmful consequences. Many people don't understand why or how other people become addicted to drugs. They may mistakenly think that those who use drugs lack moral principles or willpower and that they could stop their drug use simply by choosing to (many of us may remember the “just say ‘no’ campaign”?).

The initial decision to take drugs is voluntary for most people, but repeated drug use can lead to brain changes that challenge an addicted person’s self-control and interfere with their ability to resist intense urges to take drugs. These brain changes can be persistent, which is why drug addiction is considered a "relapsing" disease. As such, people in recovery from drug use disorders are at considerable risk for returning to drug use even after years of not taking the drug.

Most drugs affect the brain's "reward circuit" by flooding it with the chemical messenger dopamine. Dopamine is a chemical found in the brain that acts as a neurotransmitter. It is produced in the area of the brain, called ventral tegmental area or VTA. According to the latest research, our brains have evolved into a dopamine-based reward system to encourage certain behaviors that help us to survive. Thousands of years ago such survival behaviors included eating, procreating and social interaction. During an excited state, dopamine temporarily floods a synapse (a gap between adjacent nerve cells or neurons) when a pleasurable activity (gambling, sex, shopping, etc.) is anticipated. This reward system controls the body's ability to feel pleasure and motivates a person to repeat behaviors. An overstimulation of the reward circuit causes the intensely pleasurable "high" that can lead people to repeat whatever activity they were doing that provided this pleasure.

Current research suggests that the brain’s reward system has different mechanisms for cravings and pleasure. While cravings are influenced by dopamine generated in the VTA, pleasure is stimulated via other neurotransmitters in other parts of the brain called *hedonic hot spots*. When the craving circuitry overwhelms the pleasure hot spots, addiction occurs. And this is when people pursue a behavior or drug despite the consequences. Scientists have isolated many “hot spots” in the brain; each one responsible for providing unique pleasure sensations and creating a feedback loop with the subsequent reward or behavior, thereby influencing desire. When too much dopamine is distributed within the brain (or dopamine is allowed to go unchecked or removed), pleasure hot spots become overloaded.

Typically our bodies regulate the amount of dopamine through dopamine transporters (most notably, DAT) as they remove excess dopamine. However, a number of substances provide mechanisms which keep dopamine within our systems. And, as it turns out, research has been able to identify how various drugs interact with the reward system in unique ways to keep synapses artificially flooded with dopamine. And these episodes of *dopamine rush* can rewire your brain to want more drugs, leading to addiction. Below are descriptions on how heroin, cocaine and methamphetamine interact to keep excess amounts of dopamine in our systems.

- Heroin causes synapses to flood with dopamine because heroin blocks dopamine inhibitors (materials that chemically bind to dopamine so they become ineffective to act as a transmitter) in the VTA (location of dopamine production).
- For Cocaine, dopamine is blocked from being removed from the synapse (therefore keeping dopamine active). By interfering with dopamine transport, cocaine prevents the removal of excess dopamine from synapses.
- Methamphetamine reverses the natural controlled flow of dopamine into neurons, which, in turn, forces dopamine to rush into synapses instead of being removed.

As a person continues to use drugs, the brain adjusts to the excess dopamine by making less of it and/or reducing the ability of cells in the reward circuit to respond to it. This reduces the "high" that the person feels compared to the high they felt when first taking the drug: an effect known as tolerance. They might take more of the drug, trying to achieve the same dopamine high. It can also cause them to get less pleasure from other things they once enjoyed, like food or social activities.

Long-term use also causes changes in other brain chemical systems and circuits as well, affecting functions such as learning, judgment and decision-making, stress, memory and behavior.

Despite being aware of these harmful outcomes, many people who use drugs continue to take them, which is the nature of addiction.

No one factor can predict addiction, although a combination of factors influences the risk for addiction. The more risk factors a person has, the greater the chance that taking drugs can lead to addiction. Such factors include the following:

- **Biology**. The genes that people are born with account for about half of a person's risk for addiction. Gender, ethnicity, and the presence of other mental disorders may also influence risk for drug use and addiction.
- **Environment**. A person's environment includes many different influences, from family and friends to economic status and general quality of life. Factors such as peer pressure, physical and sexual abuse, early exposure to drugs, stress, and parental guidance can greatly affect a person's likelihood of drug use and addiction.
- **Development**. Genetic and environmental factors interact with critical developmental stages in a person's life to affect addiction risk. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it will progress to addiction. This is particularly problematic for teens. Because areas in their brains that control decision-making, judgment, and self-control are still developing, teens may be especially prone to risky behaviors, including trying drugs.

As one can imagine, the science of addiction is a field that needs to be explored to the fullest so that at some time – hopefully in the not-too-distant future, we will find a cure for substance dependency.

An intelligent person can rationalize anything, a wise person doesn't try Jen Knox, (American Writer)