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MINI REVIEW

Addiction: Dispelling Myths

Meera Vaswani*

Former Professor, WHO collaborating National Drug Dependence Treatment Center, All India Institute of Medical Sciences, New Delhi & Now at University of Minnesota, USA

Introduction

Addiction is a major public health problem and millions of people die due to addiction (nicotine, alcohol, and drugs of abuse). The economic consequences of drug addiction are staggering all over the World. Although great strides have been made in understanding the nature of addiction, it is still not well understood. Drug addiction can be considered a chronic brain disease that affects neurotransmission between circuits of neurons that control behavior, emotion and cognition; characterized by an excessive engagement in drug use, unsuccessful attempts in controlling drug intake, an increase in anxiety and emotional pain, and inaccurate beliefs about drug use [1]. It is a chronically relapsing disorder characterized by: (a) compulsion to seek and take the drug, (b) loss of control in limiting intake and (c) emergence of a negative emotional state (e.g., dysphoria, anxiety, irritability) when access to the drug is prevented.

The current understanding of addiction stems from the idea that addiction is produced by interaction of drugs with genetic, environmental, psychosocial, behavioral, and other factors, which causes long-term alterations in biochemical and functional properties of selected groups of neurons in the brain. In particular, addictive drugs, when taken with adequate dose, frequency, and chronicity appear to commander circuits that are intimately involved in the control of emotion and motivation, thus impairing the insight and volitional control of the addicted person. In short, drug addiction can be conceptualized as a disorder that moves from impulsivity to compulsivity in a collapsed cycle of addiction comprised of three stages:

Binge Intoxication

The first stage occurs when an individual who can potentially develop a drug addiction, consume drugs for the first time. After a drug is consumed, an increase of dopamine (DA) release occurs in the reward regions of the brain. As drug intake experiences recur, drug related rewarding experiences get associated to environmental stimuli that precede those experiences, at neuronal level. In other words, environmental stimuli become conditioned or "cued" with drug use.

Withdrawal/Negative Effect

When an individual develops drug addiction, the reward system in the brain becomes desensitized to stimulation by drugs and other rewards.

***Corresponding author(s)**

Meera Vaswani, Former Professor, WHO collaborating National Drug Dependence Treatment Center, All India Institute of Medical Sciences, New Delhi & Now at University of Minnesota, USA

Email: meeravaswani@yahoo.com

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Drug intake will trigger a much smaller increase in DA., Thus those suffering from drug addiction do not experience euphoria to the same degree when they started using the drug. **Unfortunately, these neural changes become fixed and cannot be reversed by drug detoxification. Consequently, the drug is taken for relieving dysphoria rather than for its pleasurable effects. Repeated drug intake will extend the dysphoria during withdrawal, thus producing a vicious cycle [2-4].**

Preoccupation/Anticipation

The changes in the reward and emotional circuits go together with changes in the prefrontal cortical regions, which are involved in executive functions (decision-making, inhibitory control and self-regulation). The down-regulation of DA also occurs in the prefrontal brain regions impairing self-regulation, decision-making and salience attribution. Impaired DA in the prefrontal regions weakens the ability to resist strong urges or to follow through on decisions to stop taking the drug. It also develops compulsive behavior and the associated inability to voluntarily reduce drug- taking behavior, despite the potentially catastrophic consequences. Thus alterations produced by chronic drug use, facilitate the formation of deeply ingrained emotional memories that predispose to drug craving leading to relapse.

Neurotransmitters in Drug Addiction

Neurotransmitters are endogenous neurochemicals that facilitate the communication between neurons. The initial mechanism of addictive drugs in the brain is produced by drug mimicking and blocking certain neurotransmitters such as Dopamine (DA), Serotonin (HT), Gamaaminobutyric acid (GABA), Endogenous opioid such as endorphins, which triggers a neural dysregulation.

Neural Pathways Involved in Addiction

Drugs are chemical substances that modify how neural pathways and neurotransmission work, changing behavior, emotion and cognition. Occasional drug intake causes temporary changes that revert to normal when the pharmacological effect of the substance finishes. However, long-term abuse can produce permanent changes on brain functioning due to the modification of neural pathways. These permanent changes could leave the individual with a higher tendency to fall back into a drug abuse routine [1,2,5].

Natural reinforces, such as water and food, activate the brain's reward pathway involving several parts of the brain: Ventral Tegmental Area (VTA), Nucleus Accumbens (NAc), and Prefrontal Cortex (PFC). Drugs make use of the same physiological mechanism as natural reinforces. The more intense reinforcing effects of a drug, the more persistent will be the memories associated with the drug and more powerful would be the desire or need to experience its effects again.

Addictive drugs are different from natural rewards (e.g. food, water, sex) in that DA will not stop firing after repeated consumption of the drug, the drive to consume is not satiated because they continue increasing dopamine levels, resulting in likelihood of compulsive behaviors from using drugs and not as likely when using natural rewards. This desire / needs is known as craving: an affective state in which the drug is strongly desired [6].

The Effect of Drugs on the Reward

The dopaminergic pathway is the reward pathway in the brain. It transmits dopamine from the VTA to the NAc both being central components of the circuitry underlying reward and memory of reward. Mesolimbic pathway is connected with other neurotransmission systems such as endogenous opioid, serotonergic and GABAergic system etc [7].

Dopaminergic neurons, when activated produce a rewarding effect. Commonly natural reinforcers, such as food, water or sexual behavior, activate the dopaminergic pathway. These behaviors have major significance in ensuring that rewarding pathway plays a key role in motivating learning of appetitive and consummatory behaviors. Addictive drugs also activate the reward pathway in the brain [8].

Addiction and Stress

Studies have shown that stress predisposes to opioid and other drug abuse. It is a risk factor in the vulnerability to the initiation and maintenance of drug abuse and relapse. Psychosocial stress could lead a person to adopt non-adaptive strategies that could lead to using drugs to avoid symptoms produced by stress. Corticotropin-Releasing Factor (CRF) is a neurotransmitter involved in the stress response that plays an important role in addiction. Habitual drug use could produce alterations in the CRF system

following which the reactivity to stress appears to be stronger over time, leading to compulsive pattern of drug **taking and drug-seeking** [9,10].

Summary

In the past 50 years, number of dramatic breakthroughs has occurred on the neurobiology of addiction. The neurobiological substrates for the reinforcing effects of drugs of abuse have been largely identified both at the initial site of action and in the circuitry involved. In human studies, decrease in dopaminergic function has been identified as a key element of addiction, lending support for research on the role of dopamine in addiction. Thus importance of the dopaminergic reward pathway, as one of the key common sites of action is of great significance.

However, it must be emphasized that is;

- Addiction is the result of interaction of various factors and successful treatment can come only from integrative approach involving multiple disciplines with strong connections between research and clinical practice
- In developing a conceptual understanding of addiction, it must be acknowledged that compulsive drug use cannot be understood from any single level. The development of addiction, at a minimum, involves the properties of the drugs and the neural circuits on which they operate.
- Rewarding brain system, mainly those neurons that belong to the mesolimbic dopaminergic system and certain neurotransmitters are partly responsible both for addictive behaviors and for some psychiatric disorders, especially schizophrenia and depression.
- It is also known that stress can have an impact on neurological systems. Being an environmental factor it can trigger imbalances that could result in co-morbidity

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