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Addiction Is a Brain Disease, and It Matters

Scientific advances over the past 20 years have shown that drug addiction is a chronic, relapsing disease that results from the prolonged effects of drugs on the brain. As with many other brain diseases, addiction has embedded behavioral and social-context aspects that are important parts of the disorder itself. Therefore, the most effective treatment approaches will include biological, behavioral, and social-context components. Recognizing addiction as a chronic, relapsing brain disorder characterized by compulsive drug seeking and use can impact society's overall health and social policy strategies and help diminish the health and social costs associated with drug abuse and addiction.

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Dramatic advances over the past two decades in both the neurosciences and the behavioral sciences have revolutionized our understanding of drug abuse and addiction. Scientists have identified neural circuits that subsume the actions of every known drug of abuse, and they have specified common pathways that are affected by almost all such drugs. Researchers have also identified and cloned the major receptors for virtually every abusable drug, as well as the natural ligands for most of those receptors. In addition, they have elaborated many of the biochemical cascades within the cell that follow receptor activation by drugs. Research has also begun to reveal major differences between the brains of addicted and nonaddicted individuals and to indicate some common elements of addiction, regardless of the substance.

That is the good news. The bad news is the dramatic lag between these advances in science and their appreciation by the general public or their application in either practice or public policy settings. There is a wide gap between the scientific facts and public perceptions about drug abuse and addiction. For example, many, perhaps most, people see drug abuse and addiction as social problems, to be handled only with social solutions, particularly through the criminal justice system. On the other hand, science has taught that drug abuse and addiction are as much health problems as they are social problems. The consequence of this gap is a significant delay in gaining control over the drug abuse problem.

Part of the lag and resultant disconnection comes from the normal delay in transferring any scientific knowledge into practice and policy. However, there are other factors unique to the drug abuse arena that compound the problem. One major barrier is the tremendous stigma attached to being a drug user or, worse, an addict. The most beneficent public view of drug addicts is as victims of their societal situation. However, the more common view is that drug addicts are weak or bad people, unwilling to lead moral lives and to control their behavior and gratifications. To the contrary, addiction is actually a chronic, relapsing illness, characterized by compulsive drug seeking and use (1). The gulf in implications between the "bad person" view and the "chronic illness sufferer" view is tremendous. As just one example, there are many people who believe that addicted individuals do not even deserve treatment. This stigma, and the underlying moralistic tone, is a significant overlay on all decisions that relate to drug use and drug users.

Another barrier is that some of the people who work in the fields of drug abuse prevention and addiction treatment also hold ingrained ideologies that, although usually different in origin and form from the ideologies of the general public, can be just as problematic. For example, many drug abuse workers are themselves former drug users who have had successful treatment experiences with a particular treatment method. They therefore may zealously defend a single approach, even in the face of contradictory scientific evidence. In fact, there are many drug abuse treatments that have been shown to be effective through clinical trials (1, 2).

These difficulties notwithstanding, I believe that we can and must bridge this informational disconnection if we are going to make any real progress in controlling drug abuse and addiction. It is time to replace ideology with science.

DRUG ABUSE AND ADDICTION AS PUBLIC HEALTH PROBLEMS

At the most general level, research has shown that drug abuse is a dual-edged health issue, as well as a social issue. It affects both the health of the individual and the health of the public. The use of drugs has well-known and severe negative consequences for health, both mental and physical. But drug abuse and addiction also have tremendous implications for the health of the public, because drug use, directly or indirectly, is now a major vector for the transmission of many serious infectious diseases—particularly acquired immunodeficiency syndrome (AIDS), hepatitis, and tuberculosis—as well as violence. Because addiction is such a complex and pervasive health issue, we must include in our overall strategies a committed public health approach, including extensive education and prevention efforts, treatment, and research.

Science is providing the basis for such public health approaches. For example, two large sets of multisite studies (3) have demonstrated the effectiveness of well-delineated outreach strategies in modifying the behaviors of addicted individuals that put them at risk for acquiring the human immunodeficiency virus (HIV), even if they continue to use drugs and do not want to enter treatment. This approach runs counter to the broadly held view that addicts are so incapacitated by drugs that they are unable to modify any of their behaviors. It also suggests a base for improved strategies for reducing the negative health consequences of injection drug use for the individual and for society.

WHAT MATTERS IN ADDICTION

Scientific research and clinical experience have taught us much about what really matters in addiction and where we need to concentrate our clinical and policy efforts. However, too often the focus is on the wrong aspects of addiction, and efforts to deal with this difficult issue can be badly misguided.

Any discussion about psychoactive drugs inevitably turns to the question of whether a particular drug is physically or psychologically addicting. In essence, this issue revolves around whether or not dramatic physical withdrawal symptoms occur when an individual stops taking a drug, what is typically called physical dependence by professionals in the field. The assumption that often follows is that the more dramatic the physical withdrawal symptoms, the more serious or dangerous the drug must be.

This thinking is outdated. From both clinical and policy perspectives, it does not matter much what physical withdrawal symptoms, if any, occur. First, even the florid withdrawal symptoms of heroin addiction can now be easily managed with appropriate medication. Second, and more important, many of the most addicting and dangerous drugs do not produce severe physical symptoms upon withdrawal. Crack cocaine and methamphetamine are clear examples: Both are highly addicting, but cessation of their use produces few physical withdrawal symptoms, certainly nothing like the physical symptoms accompanying alcohol or heroin withdrawal.

What does matter tremendously is whether or not a drug causes what we now know to be the essence of addiction: compulsive drug seeking and use, even in the face of negative health and social consequences (4). These are the characteristics that ultimately matter most to the patient and are where treatment efforts should be directed. These behaviors are also the elements responsible for the massive health and social problems that drug addiction brings in its wake.

ADDICTION IS A BRAIN DISEASE

Although each drug that has been studied has some idiosyncratic mechanisms of action, virtually all drugs of abuse have common effects, either directly or indirectly, on a single pathway deep within the brain. This pathway, the mesolimbic reward system, extends from the ventral tegmentum to the nucleus accumbens, with projections to areas such as the limbic system and the orbitofrontal cortex. Activation of this system appears to be a common element in what keeps drug users taking drugs. This activity is not unique to any one drug; all addictive substances affect this circuit (5).

Not only does acute drug use modify brain function in critical ways, but prolonged drug use causes pervasive changes in brain function that persist long after the individual stops taking the drug. Significant effects of chronic use have been identified for many drugs at all levels: molecular, cellular, structural, and functional (6, 7). The addicted brain is distinctly different from the nonaddicted brain, as manifested by changes in brain metabolic activity, receptor availability, gene expression, and responsiveness to environmental cues. Some of

these long-lasting brain changes are idiosyncratic to specific drugs, whereas others are common to many different drugs (6–9). The common brain effects of addicting substances suggest common brain mechanisms underlying all addictions (5, 7, 9, 10).

That addiction is tied to changes in brain structure and function is what makes it, fundamentally, a brain disease. A metaphorical switch in the brain seems to be thrown as a result of prolonged drug use. Initially, drug use is a voluntary behavior, but when that switch is thrown, the individual moves into the state of addiction, characterized by compulsive drug seeking and use (11).

Understanding that addiction is, at its core, a consequence of fundamental changes in brain function means that a major goal of treatment must be either to reverse or to compensate for those brain changes. These goals can be accomplished through either medications or behavioral treatments (behavioral treatments have been successful in altering brain function in other psychobiological disorders [12]). Elucidation of the biology underlying the metaphorical switch is key to the development of more effective treatments, particularly antiaddiction medications.

But not just a brain disease

Of course, addiction is not that simple. Addiction is not just a brain disease. It is a brain disease for which the social contexts in which it has both developed and is expressed are critically important. The case of the many thousands of returning Vietnam war veterans who were addicted to heroin illustrates this point. In contrast to addicts on the streets of the United States, it was relatively easy to treat the returning veterans' addictions. This success was possible because they had become addicted while in a setting almost totally different from the one to which they had returned. At home in the United States, they were exposed to few of the conditioned environmental cues that had initially been associated with their drug use in Vietnam. Exposure to conditioned cues can be a major factor in causing persistent or recurrent drug cravings and drug use relapses even after successful treatment (13).

The implications are obvious. If we understand addiction as a prototypical psychobiological illness, with critical biological, behavioral, and social-context components, our treatment strategies must include biological, behavioral, and social-context elements. Not only must the underlying brain disease be treated, but the behavioral and social cue components must also be addressed, just as they are with many other brain diseases, including stroke, schizophrenia, and Alzheimer's disease.

A chronic, relapsing disorder

Addiction is rarely an acute illness. For most people, it is a chronic, relapsing disorder. Total abstinence for the rest of one's life is a relatively rare outcome from a single treatment episode. Relapses are more the norm. Thus, addiction must be approached more like other chronic illnesses—such as diabetes and chronic hypertension—than like an acute illness, such as a bacterial infection or a broken bone (1). This requirement has tremendous implications for how we evaluate treatment effectiveness and treatment outcomes. Viewing addiction as a chronic, relapsing disorder means that a good treatment outcome, and the most reasonable expectation, is a significant decrease in drug use and long periods of abstinence, with only occasional relapses. That makes a reasonable standard for treatment success—as is the case for other chronic illnesses—the management of the illness, not a cure (1, 2).

Conclusion

Addiction as a chronic, relapsing disease of the brain is a totally new concept for much of the general public, for many policymakers, and, sadly, for many health care professionals. Many of the implications have been discussed above, but there are others.

At the policy level, understanding the importance of drug use and addiction for both the health of individuals and the health of the public affects many of our overall public health strategies. An accurate understanding of the nature of drug abuse and addiction should also affect our criminal justice strategies. For example, if we know that criminals are drug addicted, it is no longer reasonable to simply incarcerate them. If they have a brain disease, imprisoning them without treatment is futile. If they are left untreated, their recidivism rates to both crime and drug use are frighteningly high; however, if addicted criminals are treated while in prison, both types of recidivism can be reduced dramatically (14). It is therefore counterproductive to not treat addicts while they are in prison.

At an even more general level, understanding addiction as a brain disease also affects how society approaches and deals with addicted individuals. We need to face the fact that even if the condition initially comes about because of a voluntary behavior (drug use), an addict's brain is different from a nonaddict's brain, and the addicted individual must be dealt with as if he or she is in a different brain state. We have learned to deal with people in different brain states for schizophrenia and Alzheimer's disease. Recall that as recently as the beginning of this

century we were still putting individuals with schizophrenia in prisonlike asylums, whereas now we know they require medical treatments. We now need to see the addict as someone whose mind (read: brain) has been altered fundamentally by drugs. Treatment is required to deal with the altered brain function and the concomitant behavioral and social functioning components of the illness.

Understanding addiction as a brain disease explains in part why historic policy strategies focusing solely on the social or criminal justice aspects of drug use and addiction have been unsuccessful. They are missing at least half of the issue. If the brain is the core of the problem, attending to the brain needs to be a core part of the solution.

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11. The state of addiction—both the clinical condition and the brain state—is qualitatively different from the effects of large amounts of drugs. The individual, once addicted, has moved from a state where drug use is voluntary and controlled to one where drug craving, seeking, and use are no longer under the same kind of voluntary control, and these changes reflect changes in brain function. The exact mechanisms involved are not known. For example, it is not clear whether that change in state reflects a relatively precipitous change in a single mechanism or multiple mechanisms acting in concert, or whether the shift to addiction represents the sum of more gradual neuroadaptations. Moreover, there are individual differences in the vulnerability to becoming addicted and the speed of becoming addicted. For some individuals, the metaphorical switch moves quickly, whereas for others the changes occur quite gradually (6–10).
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