

E-Cigarettes and Teens

A Guide for Parents and Educators



A Safe Kids America Resource

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DEPUTY CHAD WILLIAMS



SAFE KIDS AMERICA
E-Cigarettes and Teens
info@safekidsamerica.org
www.safekidsamerica.org

Design by Chad Williams
Edited by Leigh Fitch
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Preface

In September 2013, the Centers for Disease Control and Prevention released a warning to the community: E-Cigarette use has more than doubled among middle school and high school students from 2011-2012. According to the National Youth Tobacco Survey, more than 1.78 million middle and high school students tried e-cigarettes in 2012. Concerns include the potential negative impact of nicotine on adolescent brain development (Dwyer et al. 2009), as well as the risk for nicotine addiction and initiation of the use of conventional cigarettes.

This guide is a resource for parents, educators, and prevention professionals who work with teens and pre-teens. Within this guide, we attempt to answer many of the pressing questions facing parents and school administrators related to e-cigarette use at school and at home. Although the science is limited, given the relatively new phenomenon of e-cigarettes, our understanding of the active ingredients most often found in e-cigarette cartridges is considerable. We should not confuse the novelty of the delivery system of a drug with it being a safe alternative.

The stakes are high for nicotine exposure during adolescence. Smoking, and now vaping, usually begins in the teen years, with 80% of adult smokers becoming addicted to nicotine by age 18. On the other hand, teens who do not consume nicotine during adolescence rarely smoke later in life. Informing teens as to the dangers of nicotine helps them make an educated and wise decision to say “no” to cigarettes and e-cigarettes. To do that, we have to understand the dangers ourselves. Let’s get started!

CHAPTER I

The e-cigarette delivery system

E-cigarettes, also known as Vape Pens, are a delivery system for Nicotine and THC (the active ingredient in marijuana). The primary difference between e-cigarettes and common cigarettes or marijuana joints is the vaporization of the drugs from liquid form, as opposed to inhalation via combustion of a leaf form, such as tobacco. The marketing of e-cigarettes as a smoking cessation device stems from this vaporization versus combustion method of inhalation. Although the science is limited, there appears to be a legitimate claim to the idea that e-cigarettes are somewhat safer than common cigarettes due to a decrease in carcinogens that are usually associated with combustion of tobacco products. Experts also warn, that while e-cigarettes may be safer that does not mean they are safe. It should also be noted that e-cigarettes may still contain many carcinogens and the base drugs nicotine and/or THC.

When discussing common cigarettes, we look at the risk profile that includes cardiopulmonary disease and a variety of cancers, among many other things. While e-cigarettes may have a slightly safer profile, they still have their own risk profile. The idea to understand is that “safer” doesn’t mean “safe”.





One of the primary concerns with nicotine is the delivery rate. Other smoking cessation devices, such as nicotine patches and gums, offer a regulated delivery of nicotine. As such, nicotine is delivered into the bloodstream very slowly. But with e-cigarettes, as with traditional cigarettes, a freebase form of nicotine is created due to the heating devices that is much more addictive. The freebase form of nicotine produced in e-cigarettes travels directly into the lungs, where it is quickly absorbed into the blood stream and delivered directly to the teen's brain.

One of the pressing questions is how e-cigarette usage affects teen smoking behavior. The Journal of Adolescent Health concluded in a 2013 longitudinal study that teen use of e-cigarettes had no cessation benefits for teens who were current tobacco users. Additionally, and more concerning, was the finding that teen use of e-cigarettes was strongly associated with heavier cigarette smoking. "Adolescents who tried to quit smoking are more likely to use e-cigarettes but less likely to no longer smoke, which suggests that e-cigarettes inhibit rather than promote cessation" (Lee et al. 2013). While statistics on e-cigarette usage support mild cessation benefits for adults, teen use *is more associated with increased and heavy use of tobacco.*

DOSAGE PROBLEMS

One benefit to adults who are trying to quit smoking is the ability to, via an e-cigarette, control the dosage of nicotine they receive in each session. We often hear teens say they like e-cigarettes because the nicotine high is more intense than smoking a traditional cigarette. That more intense high is also associated with self-dosing nicotine. Where the adult smoker may slowly reduce the milligrams of nicotine they receive per smoking session, many teen users are increasing their shot of nicotine. Let's take a look at how they do this.



An average traditional cigarette contains about 1mg of absorbed nicotine. Cigarettes actually have a lot more nicotine than that, but it is only about 14% efficient as a delivery system due to nicotine lost through combustion and second-hand smoke. The nicotine content varies with each type and brand of cigarette, with lights and ultra-lights having less nicotine than regular cigarettes. With the average of 1mg per cigarette, a person smoking a pack (or 20 cigarettes) a day would inhale about 20mg of nicotine. It's difficult to tell exactly how much of that 20mg of nicotine actually makes it into the brain. There are many factors which contribute to the absorption rate of nicotine, and those factors are the same for traditional cigarettes and e-cigarettes.

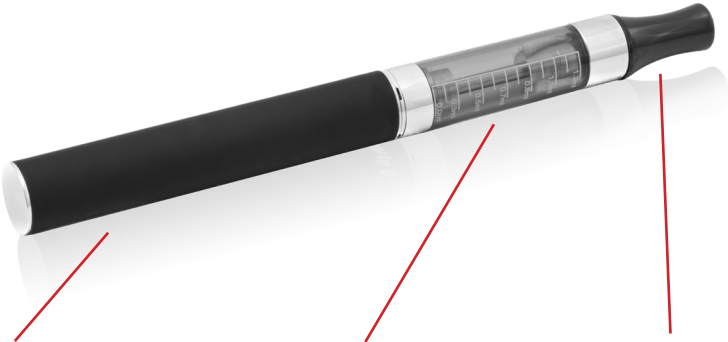
DOSAGE PROBLEMS

Nicotine-based cartridges sold for use in e-cigarettes also come in varying strengths and are rated as milligrams of nicotine per milliliter of fluid. The cartridge strength ranges from 0mg/ml for a simple flavored liquid cartridge that has no nicotine to 36mg/ml or more for stronger cartridges. Generally, a milliliter cartridge holds about 20 drops of fluid, so each drop of a 20mg/ml liquid contains approximately 1mg of nicotine. Most users self-report vaping about 4-6 milliliters per day. This, of course, will vary greatly per user. A user that vapes 5 milliliters of 20mg/ml nicotine-based liquid may absorb about 100 milligrams of nicotine. However, that assumes a 100% absorption rate and that is unlikely.

We know that second-hand vapors contain much less nicotine than second-hand smoke, so the efficiency is much greater. Science has yet to determine to what extent. Most e-cigarette users claim about 60-70% efficiency for their e-cigarettes. At that rate, the e-cigarette user above would absorb about 60-70mg of nicotine per day... more than three times the amount of smoking a pack of cigarettes per day. Once again, many things are unknown about dose efficiency and rates of absorption for e-cigarettes, which should lead a parent to hesitate before allowing their teen to use e-cigarettes.



We now have a basic understanding of e-cigarettes and some of the potential problems they present to teens. The first step in formulating a prevention response is to be able to identify if you have a problem. You have to know what you are looking for, so let's take a look at what an e-cigarette is and how it works.



Rechargeable Battery

Most e-cigarettes can be plugged into a wall socket or computer via a USB connector to recharge.

Liquid Cartridge and Heating Coil

The heating coil vaporizes the liquid nicotine or marijuana inside the cartridge and is subsequently sucked through the mouthpiece.

Mouthpiece

The mouthpiece sometimes unscrews to allow the e-cigarette to be refilled. Other e-cigarettes have replaceable cartridges.



TYPES OF E-CIGARETTES



Two-Piece e-cigarette

Later model of e-cigarette that evolved from the three piece e-cigarette. The atomizer is built into the battery section.



Three-Piece e-cigarette

Earlier model of e-cigarette. These are harder to find currently. The atomizer is a separate piece from the battery.



Disposable e-cigarettes

The disposable e-cigarettes are cheaper than entry level models and meant to be used to introduce the new e-cigarette user to the product. They usually come in different flavors, such as fruit juice and bubble gum.



E-cigar

E-cigars contain more nicotine liquid than e-cigarettes, so the user gets more puffs per cartridge. They come in two and three-piece units.

TYPES OF E-CIGARETTES



E-pipe

Similar to the e-cigarette, the e-pipe is simply shaped differently. The delivery system and cartridge system is the same as e-cigarettes.



E-cigarette with Nicotine Tank

In earlier models of Pen Vaporizers, the tank is refilled by unscrewing the mouthpiece and pouring the nicotine liquid directly into the tank. Later models have replaceable cartridges. Both models are currently on the market.



TYPES OF VAPORIZERS

Pen Vaporizers

Also called Vape Pens, these are the current systems in the vaporizer market. They come in all shapes, sizes, and colors. Different models are designed to vaporize liquid nicotine, liquid marijuana, marijuana concentrates, and dry leaf marijuana. See Chapter 2 for more details.



TYPES OF VAPORIZERS

Palm Vaporizer

Palm vaporizers evolved out of e-pipes. They are small and designed to be used discreetly with dry leaf marijuana and marijuana concentrates. There may be palm vaporizers that use nicotine cartridges.



Inhaler Vaporizer

Inhaler vaporizers are made with one idea in mind, discreet use of marijuana. These vaporizers are designed to vape liquid marijuana or dry leaf marijuana with a device that looks like a common inhaler.



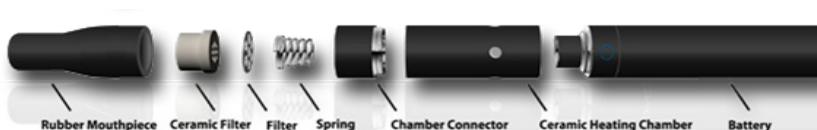
CHAPTER II

Marijuana and e-cigarettes

Putting the problems with teens and nicotine aside for a moment, there is a significant issue with the increase of adolescent use of marijuana. Teens currently use e-cigarettes to vaporize (commonly called “vaping”) marijuana discreetly, many time on school grounds. Using e-cigarettes to vape marijuana leaves very little odor and no smoke. Teens figured out that using these devices to vape marijuana allows them to use the drug wherever they choose. It is very difficult to tell the difference between nicotine and marijuana cartridges. However, there are some clues with the devices themselves. In Chapter 2, we will discuss Vape Pens and other devices that are sold and modified for use with marijuana, liquid marijuana, and marijuana concentrates.

Dry Herb Vaporizer

One of the first types of marijuana specific vaporizers is the dry herb vape pen. This pen is designed to vape dry marijuana and concentrates. As you can see from the pictures below, there is no cartridge for use with liquid nicotine or liquid marijuana. Dry marijuana is placed in the ceramic heating chamber and vaporized via an internal heating element. One of the clues that the vaporizer is used for dry organics is the inclusion of a ceramic filter or internal screen.



MARIJUANA VAPORIZERS

Replaceable Cartridge Vaporizers

These vaporizers are more closely related to e-cigarettes. However, certain brands are designed specifically for marijuana. The brand shown below comes with a multitude of cartridges that contain marijuana concentrates of specific strains, such as Sativas, Indicas, and hybrids. The strains are color-coded.



MARIJUANA VAPORIZERS

Marijuana Specific Cartridges

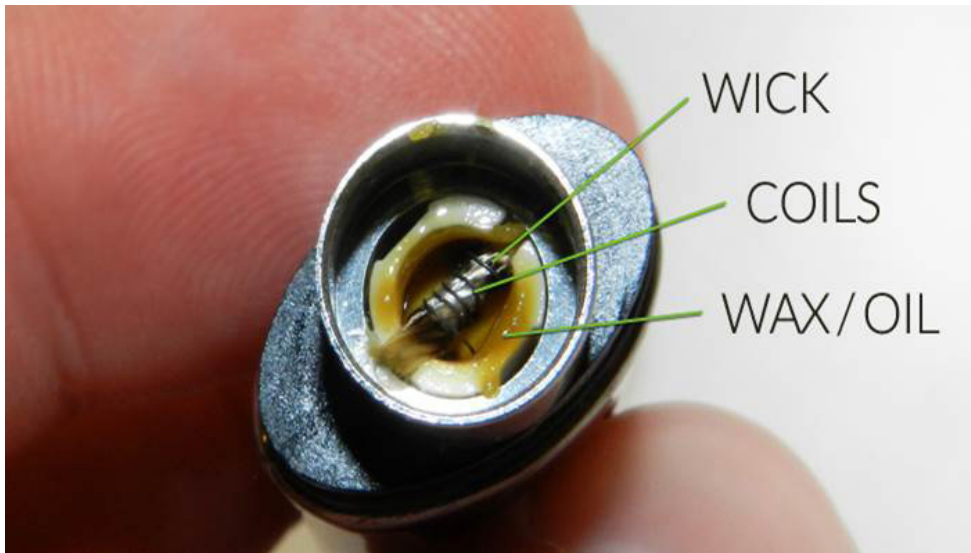
Marijuana-specific cartridges (as seen on the previous page) and refill kits are sold online and in dispensaries. Look for terminologies associated with marijuana. Many times (but certainly not all times) the liquid is dark. Also look for marijuana tincture dropper bottles. Most marijuana cartridges can be screwed onto e-cigarette batteries. Marijuana cartridges are often called “Dank Tanks”.



MARIJUANA VAPORIZERS

Parts will tell the tale

As stated earlier, look for pens that have no cartridge or tanks. Also look inside the pen for sticky residues. Some pens are designed to specifically vaporize marijuana concentrates (see picture below).



Globe Attachments

The globe attachment creates a miniature nail and dome bong used to smoke dabs (marijuana concentrates). You can see the titanium nail inside the globe of the pen vaporizer. This is a single-purpose attachment used strictly to smoke marijuana concentrates.



CHAPTER III

Nicotine and the Teen Brain



The marketing claims by the e-cigarette industry center around the idea that e-cigarettes are a safer alternative to smoking cigarettes. Indeed, e-cigarettes contain less carcinogens (although they still contain carcinogens) than traditional cigarettes. This argument is relevant to adults wanting to wean themselves off of traditional cigarettes. The problem is the story is not so simple for teens. Putting the carcinogens aside, let's discuss nicotine and the effects it has on the adolescent brain. It is an important topic considering the explosion in e-cigarette popularity among teens. It is critical they make wise decisions about using nicotine-based products and not simply buy into the marketing rhetoric. Presenting with them a unified, accurate drug prevention message is our responsibility. A good start is to understand how the drug, nicotine, affects a teen.

A major concern, particularly when discussing how e-cigarettes are marketed to teens, is the difference in how nicotine affects teen brains, as opposed to adult brains. While nicotine causes cellular damage to brain cells regardless of age, the damage done to the teenage hippocampus is striking. We know from the volumes a research done on how marijuana affects the teen brain that the hippocampus is the memory center of the brain. We'll look more into how nicotine affects the hippocampus in Chapter 3. Additionally, teens are much more susceptible to depression, cardiac irregularities, and persistent nicotine addiction when using nicotine. Simply put, the stakes are much higher for teen drug users.

NICOTINE AND BABIES

Before we dive into the adolescent brain, we want to discuss vaping nicotine while pregnant. This is great information for teens and adults who may be expecting. This first section will cover how nicotine affects babies. We include this so any expectant mothers thinking about switching to e-cigarettes from traditional cigarettes with the belief it will not harm the baby will have the truth. Make wise decisions, especially when there is a baby involved. Make it a reason to quit smoking altogether!

The first question one must ask is, “What exactly harms the baby inside the womb during pregnancy?” Is it the carcinogens in cigarette smoke? Fortunately, science is fairly clear on this topic. It is nicotine itself that causes the majority of the prenatal neuronal problems for the child. A recent article in *Current Neuropharmacology* explains, ‘As nicotine addiction is the factor preventing many women from smoking cessation during pregnancy, nicotine replacement therapy (NRT) has been suggested as a better alternative for the fetus. However, the safety of NRT has not been well documented, and animal studies have in fact pointed to nicotine per se as being responsible for a multitude of these detrimental effects’ (Wickstrom, 2007).

That simply means nicotine, regardless of its delivery system, is responsible for most of the defects we see in fetuses when the mother smokes. Considering the dosage issues we discussed in Chapter 1, e-cigarettes may prove to be an unwise choice. Wickstrom goes on to conclude, “... a total abstinence from all forms of nicotine should be advised to pregnant women for the entirety of gestation.” The take-home message is e-cigarettes are not a safe alternative for an expecting mother. The only safe alternative is to quit putting nicotine, or any drug for that matter, in your body while you are pregnant.



NICOTINE AND THE TEEN BRAIN

What's true for unborn babies holds true for teens. The point is simple, nicotine and THC are the primary agents of destruction for the adolescent brain, not necessarily the carcinogenic byproducts of smoking. This is important because e-cigarettes still deliver nicotine and THC directly to teen brains. Even if many of the carcinogens are gone, which is certainly healthier for adults in the long run, the primary dangers for teens still exist. Marketing efforts for the e-cigarette industry will not tell teens about this fact. They simply have no interest in promoting any of the consequences of putting a drug into the adolescent developmental process. That education is left for us. Are we succeeding in educating our teens properly? Given the numbers of teens using e-cigarettes today, my guess is probably not. So, let's learn together and make that conversation happen.

Nicotine is a highly addictive stimulant. When we say highly addictive, we mean very highly addictive. When inhaled, via traditional cigarettes or e-cigarettes, it enters the bloodstream, crosses the blood brain barrier, and enters the brain within 10-20 seconds. Addiction to nicotine is one of the hardest to overcome, with addiction characteristics being similar to cocaine and heroin. Compounding the problem, a teen's chances of becoming addicted to any drug are greater than an adult. Mix that increased sensitivity and the addictive nature of nicotine and you have a recipe for an addicted teen. Additionally, rates of addiction to nicotine are relative to exposure (how much nicotine they absorb by smoking or vaping), so increasing doses with e-cigarettes to experience the more intense high we discussed earlier results in an increased chance the teen will become addicted. That fact e-cigarettes allow one to control dose may be helpful for the adult trying to quit. However, it works against teens who are trying to chase the more intense high.

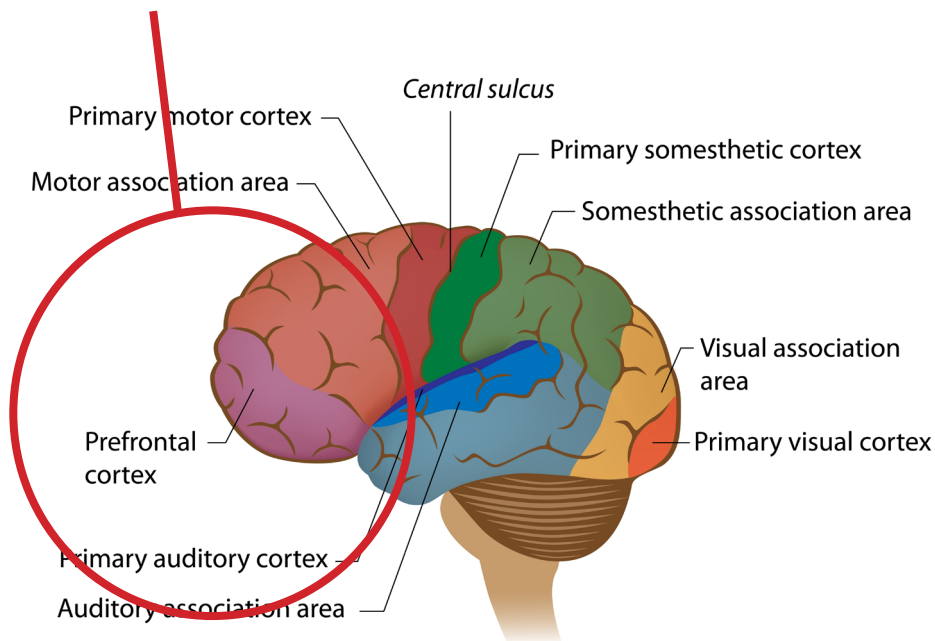
We discuss the adolescent brain development in detail in the Parental Reference Guide: Teens and Marijuana Part 1. To summarize, the teen brain is going through a critical reorganization and maturation process. This continues until about age 25. This maturation process identifies neuronal connections that are being used and insulates those connections. At the same time, the brain actually has too many neurons (the basic brain cell), so it prunes away those neurons that are not being used. That process is called pruning. Science is just beginning to unlock the mysteries of the adolescent maturation process, but what is abundantly clear is the damage drugs, such as nicotine and marijuana, can do to the brain during this process.

OPPORTUNITY OVER OBSTACLES

We discuss the effects of marijuana on the teen brain in the Teens and Marijuana guide series, so we will focus on Nicotine here. The first lesson about teen brain development we present to teens is that this is a time of great opportunity for them. Most adolescent development seminars I've seen focus too heavily on the consequences and leave teens believing this is a time of great turmoil. Our outreach to teens has been most successful when we show them just how promising their future can be. We suggest starting your conversation in the same manner. Certainly, we have to discuss the obstacles, but do so after establishing that they have a great opportunity to build a powerful computer (brain).

We know that nicotine is a neuroteratogen, meaning it causes malformations of an embryo or fetus. The question is, how is that translated to adolescent development? Two of the areas of the teen brain that are most prone to developmental problems caused by drug use are the prefrontal cortex and the hippocampus. The prefrontal cortex, also called the forebrain, controls executive function, attention-based performance, and risk aversion, among other things. The hippocampus is responsible for memory and mood regulation. Let's look at how nicotine affects both.

Prefrontal Cortex



NICOTINE AND THE TEEN BRAIN

We know now adolescent exposure to nicotine, even in small amounts, leads to adult attention deficit disorders. Science discovered physical changes in the prefrontal cortex, caused by nicotine exposure, were the cause of these disorders. In prefrontal networks, nicotine modulates information processing on multiple levels by activating and desensitizing nicotine receptors on different cell types and in this way affects cognition (Goriounova et al. 2012). That is a complicated way of saying nicotine disturbs the regular functioning of receptors the cells need to work properly. Goriounova goes on to say, “Studies in human subjects indicate that smoking during adolescence increases the risk of developing psychiatric disorders and cognitive impairment in later life. In addition, adolescent smokers suffer from attention deficits, which aggravate with the years of smoking.”

The take-home message from this is that nicotine exposure during teen years causes developmental issues in the part of the brain that controls attention performance and the ability to understand complex ideas. We need to be able to pay attention and understand complex ideas to be successful as adults. Explaining this consequence as an obstacle to building a powerful computer has been received well by teens we work with.

Hippocampus



NICOTINE AND THE TEEN BRAIN

The hippocampus is a structure in the limbic system of the brain that is responsible for memory and mood regulation. It is very sensitive to drug use by teens and causing developmental issues can lead to a range of persistent problems in adulthood. A 2013 study published in the *Journal of Academic and Industrial Research* noted hippocampal cell damage in adolescent hippocampal cells of rats after nicotine exposure (Tewari et al. 2013).

Cell damage and cell death in the hippocampus due to nicotine exposure in adolescence is well-documented, but how does this manifest itself in teen behaviors? Given that the hippocampus is responsible for memory and mood regulation, it may be expected that teens using nicotine would have problems with memory tasks and mood-behaviors. That is exactly what psychologists and behavior scientists discovered. In addition to anxiety and depressive behaviors that continue into adulthood, adolescent nicotine exposure leads to cognitive impairments as well. Interestingly, nicotine can have beneficial effects on the adult's cognitive abilities, as long as the adult was not exposed to nicotine during adolescence.

Lastly, does this cellular damage repair itself with abstinence? The number of cells does not typically change once neural mitosis is complete (Slotkin, 2002). That simply means that, unlike fetal brain development, most adolescent brain cells damaged during nicotine exposure are not repaired or regenerated. It speaks to a permanence of cellular damage caused during adolescence. However, science has much more work to do in this area and I do not take that as the final word on the permanence of cell damage caused during our teen years by nicotine. It should be taken as a warning to our teens and parents on the possible consequences of introducing a drug like nicotine into that developmental process. Remember, they are building the best computer they can during adolescence; it is unwise to introduce malware, so to speak, into that system via nicotine or THC exposure.

There is a great irony in teen brain development... the teen brain is very sensitive to toxins at a time when teens are prone to risky behavior, including experimenting with drugs. We consistently explain to teens that we want them to make wise decisions. Rarely do we give them the information to make those decisions. Sharing the lessons of this guide is a great start.

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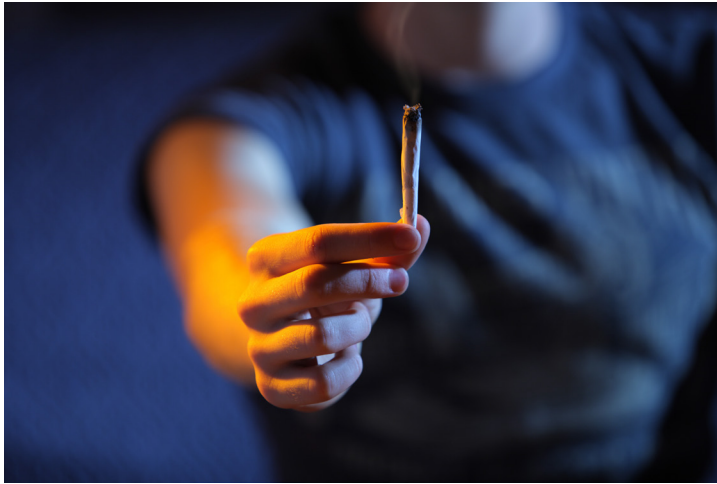
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ADDITIONAL RESOURCES

These Parental Guides are meant to inform parents and educators so they may recognize and respond to the potential dangers our teens face. The Guides are a series that include all drugs, as well as Internet/Smartphone safety education. The guides will be available at www.safekidsamerica.org with release dates throughout 2014.



Teens and Marijuana
Parts 1-3



Teen Prescription Drug
Abuse: Part 1



Teen Prescription Drug
Abuse: Part 2

PARENTAL GUIDE SERIES



Teens: The New Face of Heroin



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