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Clinical Case Conference Electronic cigarettes: a review of safety and clinical issues

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This clinical case conference discusses three cases of patients using electronic cigarettes (ECIGs). ECIGs, also referred to as electronic nicotine delivery systems (ENDS) or ‘e-cigarettes’, generally consist of a power source (usually a battery) and heating element (commonly referred to as an atomizer) that vaporizes a solution (e-liquid). The user inhales the resulting vapor. E-liquids contain humectants such as propylene glycol and/or vegetable glycerin, flavorings and usually, but not always, nicotine (Etter, 2012a). Each patient’s information is an amalgamation of actual patients, and is presented and then followed by a discussion of clinical issues.

CASE 1: NEW ELECTRONIC CIGARETTE USER

A 21-year-old male college student presents to his primary care physician for a health maintenance visit. As part of routine screening, he is asked about tobacco product use. He reports that he will occasionally smoke cigarettes when he is drinking beer at a party, and he has smoked tobacco from a hookah several times with friends. He recently began using an ECIG and reports that he has gradually been using it more frequently, so now he is using it (“vaping”) six or eight times each day. He has started smoking tobacco cigarettes more often, usually when he can get them from friends, and he has also been using a hookah nearly every weekend for the past two months. He has not thought about quitting his use of ECIGs or tobacco products, because nearly all of his friends are smokers. He is concerned that he has been coughing much more often over the past few months, and asks whether ECIGs cause problems.

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Case 1 Discussion

Assessment of tobacco use disorder—Physicians, nurses, and other healthcare clinicians should ask patients about tobacco product use on every possible occasion. This includes routine health maintenance examinations and specific complaints that may be related to tobacco use (respiratory infections, cough, etc.). This provides an opportunity to determine whether a pattern is developing that may signal the change from youthful experimentation to development of a diagnosable tobacco use disorder (TUD). In Case 1, a young adult has started using tobacco products regularly and is escalating his use.

When asking about nicotine or tobacco products, it is often useful to start with an open-ended question, such as, “What types of tobacco products have you used?” This provides an opportunity to obtain information on tobacco products other than cigarettes, such as cigars, cigarillos, pipes, hookah pipes, smokeless tobacco (snuff, snus), and ECIGs. It is helpful for clinicians to ask about specific products by name, since patients may not consider ECIGs to be a “tobacco product” or may not realize that a hookah pipe contains tobacco (Eissenberg, 2013). For each affirmative response, follow-up questions should be about frequency and patterns of use. Additional questions help gather information about consequences, whether medical, related to interpersonal difficulties due to nicotine use, financial, or legal problems. This helps the clinician make an initial determination about potential severity.

Another determinant of severity is physical dependence on nicotine. There are several tools available to help clinicians determine a patient’s level of physical dependence. The Fagerström Test for Nicotine Dependence (FTND) is a validated questionnaire that has been available for over two decades (Heatherton, et al., 1991). The higher the FTND score, the more physical dependence a patient has on nicotine, and the more withdrawal discomfort the patient is likely to have. This helps to determine the need for nicotine replacement therapy, and to help provide patients with some anticipatory guidance about potential withdrawal symptoms with a quit attempt, or consequences of escalation of nicotine use. However, the FTND was validated with tobacco cigarettes, so it may not be directly applicable to ECIGs or to hookah pipe use (Fagerström and Eissenberg, 2012). Until product-specific scales are developed to evaluate the severity of physical dependence, it is worthwhile to recognize that frequent use of any nicotine product may lead to physical dependence.

Diagnosis of a TUD is based on criteria from the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5; APA, 2013). This list of clinical criteria reported within a 12-month period is a guideline for clinicians that determines the presence and severity of the diagnosis (Table 1). Asking open-ended questions about these criteria related to ECIG use not only helps to gather information to make a diagnosis, but also helps the ECIG user to recognize problems associated with ECIG use.

Risk factors for development of addiction—When a TUD is diagnosed, then the clinician can present this diagnosis to the patient and begin the process to address it. If a patient has tried ECIGs or tobacco products, but has not yet progressed beyond experimentation to a discrete disorder that is diagnosed using clinical criteria, then the clinician can assess for risk factors that indicate the likelihood of progression from experimentation to a TUD.

Most U.S. adolescents will experiment with tobacco before age 18 years (APA, 2013), and many will progress to development of TUD by late adolescence. Adolescents overestimate peer use of tobacco products (Page et al., 2002), and peer group is a significant influence on initiation of tobacco use (Maxwell, 2002). Whether ECIG vaping or tobacco smoking, peer influence plays a role in awareness and initiation of ECIG use among young adults (Choi and Forster, 2013). Clinicians should ask patients about peer use of ECIG and tobacco products, in order to determine whether there is a higher risk of continuation of ECIG use.

There is a significant genetic component influencing tobacco use (Maes et al., 2004), which is likely to play a role in progression of ECIG use from experimentation to regular use. Asking about family use of ECIGs and tobacco products also helps the clinician to make a determination about risk of progression that can lead to long-term use and development of health problems.

A recent study of multiple emerging tobacco products revealed that higher levels of education are associated with ECIG use, contrary to cigarette use patterns, which suggests that ECIGs may even have the capacity to reverse the previous trend of tobacco use denormalization in this group (McMillen, et al., 2012). In Case 1, the patient is in college and has been experimenting with multiple forms of tobacco, especially due to the influence of his peer group. These factors increase his risk of continuing to escalate use of ECIGs or tobacco, leading to future consequences.

Use of ECIGs may lead to use of tobacco products by people who have never smoked a cigarette or those who had a TUD in the past, which increases both individual and public health risks. Once exposed to nicotine in a tobacco using culture, individuals may be at higher risk of progressing to regular cigarette use (DiFranza and Wellman, 2005). Use of multiple forms of tobacco or nicotine increases levels of nicotine exposure and increases the risk of a tobacco use disorder, relative to the use of cigarettes only (Bombard et al., 2009). Nicotine exposure upregulates nicotine receptors in the reward centers of the brain, which increases the potential for development of early TUD and facilitates the process of escalating from periodic use to regular use, including the leap to daily cigarette smoking (DiFranza and Wellman, 2005). Even people who have quit smoking cigarettes may relapse to nicotine addiction after using ECIGs.

Providing information to patients—Periodic health maintenance examinations are opportunities for preventive health-related counseling by health care providers about tobacco use, as well as other issues (Boulware et al., 2007). A healthcare office visit may serve as a trigger for tobacco use quit attempts. Patient-initiated discussions are especially important, since they represent an implied willingness to quit and seek consultation for this. Patients who use tobacco products perceive the advice from a healthcare professional to quit as a strong motivator for a cessation attempt (Tessaro et al., 1997; Kreuter et al., 2000; Whitlock et al., 2002).

Once the diagnosis of a TUD is made, both acute and long-term treatment planning is necessary; simple admonitions to stop are sometimes helpful if the diagnosis is made early, but in most cases are insufficient (Weaver et al., 1999). Many patients who smoke or use

ECIGs may be ambivalent about changing behavior, so the clinician should express empathy without confrontation, which shows respect for the patient's self-determination. Providing appropriate, accurate information about risks of ECIGs, as well as benefits compared to tobacco products, and encouraging healthy choices, can help patients to make the best informed decision about changing behavior with respect to use of tobacco, including ECIGs (see the accompanying review article about ECIGs in this issue). Physicians should involve the patient proactively in the process of problem-solving, while reminding the patient of responsibility for all actions. The responsibility of the practitioner is to motivate the patient to seek recovery from nicotine use instead of blaming the patient for being unmotivated to change (Weaver et al., 1999).

Healthcare professionals can provide clear and unbiased information to patients about ECIGs and other tobacco products. Accurate information about the relative risks and potential harms of these products helps a patient to make an informed choice about continuing to use particular products, or to make a quit attempt. Providing information and answering a patient's questions in a nonjudgmental manner shows respect for the patient's autonomy. This also sets the stage for assistance with making a quit attempt when the patient is ready to do so. The patient in Case 1 can be provided with information about his risk for a TUD, which can help him to make a decision about whether he will change his use of tobacco products, including ECIGs.

CASE 2: EXPERIENCED NICOTINE USER WHO WANTS TO QUIT

A 52-year-old woman has been smoking at least one pack per day of tobacco cigarettes since she was 19 years old. She has made several quit attempts in the past seven years with nicotine patches and bupropion, but has not been successful. Last year she tried to quit by gradually switching to an ECIG, primarily because her workplace prohibited smoking in the building where she works. However, she has continued to smoke tobacco cigarettes at home and escalated her use of the ECIG at work due to cravings for nicotine. She has even dripped nicotine liquid onto the ECIG heating element in an apparent effort to obtain more nicotine. She wants to quit her use of nicotine altogether. She wants to know whether ECIGs can be used to quit smoking tobacco.

Case 2 Discussion

Can electronic cigarettes help with smoking cessation?—Each year, 69% of tobacco cigarette smokers say they want to quit (CDC, 2011), and 52% make a quit attempt (CDC, 2012). However, relapse rates are very high—most smokers will fail to quit smoking (approximately 6% are successful: CDC, 2011). Existing smoking cessation methods can help to a certain extent by increasing rates to 11-30% (Fiore, 2008). However, quit rates are still relatively low. ECIGs have the potential to deliver nicotine and to address some of the stimuli associated with smoking (such as hand-to-mouth movement), and thus theoretically could be a useful quit method.

Most studies on the use of ECIGs as an aid to smoking cessation have reported on perceptions of ECIG use to quit smoking. Data from several studies shows that many ECIG users surveyed do use ECIGs to quit smoking (Dawkins et al., 2013; Foulds et al., 2011;

Goniewicz et al., 2013; Vickerman et al., 2013) and/or to reduce use of tobacco cigarettes (Kralikova et al., 2013). However, surveys of ECIG users may be biased, as they recruit from websites frequented by ECIG enthusiasts, and results are based on self-report (Odum et al., 2012).

Case reports (e.g., Capponetto et al., 2011) have also been published, and describe tobacco cigarette smokers who are able to quit smoking using ECIGs. However, only five studies have actually assessed whether or not ECIGs can help tobacco cigarette smokers to quit, and of those, only two were randomized trials with a control condition. Two single-arm trials (without control groups) of tobacco smokers not wanting to quit have shown reductions in tobacco smoking (a third to half were able to do this), and low to moderate quit rates of 14 – 23% with ECIG use (Polosa et al., 2011; Capponetto et al., 2013). The two randomized controlled trials that have been published showed that participants who received ECIGs reduced their smoking, although no differences were observed across groups in terms of quit rates (Bullen et al., 2013; Capponetto et al., 2013). Some participants did quit smoking completely: 11% at 12 weeks and 9% at one year (Capponetto et al., 2013). Importantly, both of the published randomized controlled trials used ECIGs with low to moderate doses of nicotine, which may have impacted the quit rates reported (because low nicotine levels may not have adequately suppressed withdrawal, leading participants to return to tobacco cigarettes). In conclusion, whether or not ECIGs can help tobacco smokers quit smoking is still unclear. Also, as previously discussed, the use of ECIGs may have unknown risks (see Case 1 Discussion). This information should be shared with patients.

Abuse of electronic cigarettes—Although ECIGs may have the potential for less physical harm compared to tobacco, due to the fact that they do not deliver carbon monoxide and some carcinogens, they can deliver nicotine, a mild psychomotor stimulant that is addictive. As with other drugs of abuse, users may escalate the dose due to physical tolerance. Users may also tamper with the ECIG delivery system to provide larger doses of nicotine, or make changes to the liquid that is used in these devices (“e-liquid” or “juice”).

One of the ways in which users tamper with ECIGs is by “dripping” (McQueen et al., 2011). To engage in “dripping”, the user applies the ECIG solution directly from the bottle onto the heating element of the ECIG and then inhales the vapor produced. Dripping has gained popularity through dissemination via the internet, and specialized “drip tips” are available for purchase. This process may provide a larger dose of nicotine when a nicotine-containing solution is used, but also allows for higher exposure to byproducts of heating the other ingredients of the liquid, such as formaldehyde (Shihadeh et al., 2013). The patient in Case 2 recognizes that dripping can be dangerous and is a sign of worsening problems from her use of ECIG, which helps to increase her intrinsic motivation to quit. This dangerous use of ECIGs in ways for which they were not designed also fulfills some of the DSM-5 criteria for a clinician to make a diagnosis of TUD (Table 1).

Another method of tampering with ECIGs is by mixing different e-liquids. Users may add different flavorings and diluents, or may purchase e-liquids with higher concentrations of nicotine. Vodka or other forms of alcohol may also be added to the original e-liquid. Adding more nicotine or alcohol may expose the ECIG user to more dangerous levels of toxicants,

especially with combinations of substances. In addition, some of the chemicals in e-liquids may be flammable, which poses a risk of injury, especially if the person mixing the e-liquid is inexperienced or does not have protective equipment.

The voltage of some types of ECIGs may also be adjusted by the user. Higher voltage appears to increase the nicotine yield of the vapor (Shihadeh et al., 2013). Variable-voltage ECIGs are available for purchase. These are usually larger than many basic types of ECIGs that more closely resemble cigarettes, and are often more complex to operate. Some users may alter an original non-variable-voltage ECIG by adding more batteries or a larger battery to increase the voltage output, but this may damage the ECIG or even lead to battery leakage or explosion.

These alterations of typical ECIG use by dripping, e-liquid mixing, or adjusting the voltage can have dangerous consequences for the user. Asking patients about unorthodox use of ECIG is helpful to determine the risk of harm and the severity of the TUD based on amount of nicotine use and hazardous use. The potential decreased toxicant exposure associated with ECIG use relative to burning tobacco (e.g., lower exposure to carbon monoxide and tobacco-specific nitrosamines) and utility for possible tobacco cessation may be offset to some degree by using ECIG in an unorthodox manner. Patients should be cautioned that even though these methods of ECIG tampering have become popularized on the internet, they still may be dangerous and can have long-term consequences. This discussion can help to enhance a patient's motivation for change, especially by reducing immediate harm.

Role of behavioral treatment with pharmacotherapy—Randomized control trials may eventually provide data consistent with ECIGs playing a role as a tobacco smoking cessation aid. ECIGs are a different system of nicotine replacement than other FDA-approved smoking cessation pharmacotherapies such as nicotine patches, gum, or lozenges. Nicotine nasal spray is a form of nicotine replacement therapy (NRT) available by prescription that, like ECIGs, involves frequent dosing of small amounts of nicotine. Use of the nasal spray is limited to six months in order to prevent development of physical dependence on nicotine when the goal of therapy is cessation of tobacco (Joseph and Fu, 2003). However, ECIGs are not FDA-approved for this indication, are unregulated at present, and current labeling does not indicate a recommended period of use.

In addition to NRT, other available pharmacotherapies for tobacco cessation are varenicline (Chantix) and bupropion (Zyban). Varenicline is a nicotine partial agonist in oral tablet form that is started while the patient still is using tobacco and is prescribed for three months, with a possible extension to six months of therapy to achieve tobacco cessation (Stack, 2007). Bupropion is a prescribed polycyclic antidepressant that is also started prior to tobacco cessation and continued for 3-6 months of therapy (Swan et al., 2003). Randomized control trials demonstrate that NRT, varenicline, and bupropion all increase the long term success of quit attempts for tobacco smoking (Hughes, 2009). These pharmacotherapies have not been studied with respect to their effectiveness in assisting with cessation of ECIG use. They have been shown to be effective for assisting with achieving tobacco abstinence, so may also be useful in assisting with ECIG abstinence.

All forms of pharmacotherapy for smoking cessation, whether NRT or other prescription cessation aids, are recommended to be used in combination with a behavioral program for successful smoking cessation. Pharmacotherapy is intended to be an adjunct to behavioral treatment for TUD and should not be used alone. There are multiple forms of behavioral therapy available, from patient-initiated assistance using a toll-free telephone quitline or website, to smoking cessation group counseling or individual therapy based on cognitive-behavioral principles. Pharmacotherapy with behavioral therapy is more effective than pharmacotherapy alone, and has more sustained effects (Stead and Lancaster, 2012). Patients who use NRT or prescribed pharmacotherapies have access to behavioral programs that are funded by the manufacturer, since the manufacturer has a vested interest in improving quit rates for those who use the cessation pharmacotherapy. However, ECIG manufacturers do not provide any funding for behavioral cessation programs, and actually have a financial incentive for patients not to be successful at their cessation efforts. Patients who use ECIGs as a pharmacotherapy option for tobacco cessation do not have that formal connection to a behavioral program at even a minimal level. Without the behavioral component as integral to the smoking cessation effort, success rates may be lower than they otherwise would be. If a healthcare clinician is aware that a patient is using ECIGs as a form of smoking cessation pharmacotherapy, then a recommendation and referral to a behavioral treatment program for smoking cessation may improve the likelihood of success for the patient.

CASE 3: ELECTRONIC CIGARETTE USER WITH NO TOBACCO USE

A 31-year-old woman has never used tobacco products, but recently started using an ECIG. Her husband has been a tobacco smoker for years, and he recently started using ECIGs due to a smoking ban at the bar where he works. She tried his ECIG several times to see what it was like, and found she enjoyed the effects after several attempts. She now uses the ECIG (“vapes”) several times each day.

Case 3 Discussion

Are electronic cigarettes safe?—Even though ECIGs have reduced exposure to carbon monoxide and carcinogens relative to tobacco cigarettes, there may be significant health risks associated with long-term, daily ECIG use. ECIG users (“vapers”) who use a nicotine-containing solution likely are exposed to nicotine, and nicotine is not a safe substance. Long-term nicotine exposure promotes atherosclerosis in animal models (Lee and Cooke, 2011), which can lead to cardiovascular consequences. Nicotine may also have cancer-promoting qualities (Warren & Singh, 2013) and thus chronic, long-term administration of this drug may not be risk free. Bottles containing e-liquid to refill ECIG cartridges may contain up to 720 mg of nicotine, which, if ingested, could be toxic (Etter et al., 2013).

Substances found in ECIG vapor and e-liquids may include a variety of compounds in addition to nicotine, some of which are added by manufacturers to enhance the user experience (flavor, fragrance, aroma transporters, and food dyes). ECIGs use may result in exposure to carcinogenic tobacco-specific nitrosamines, allergens such as pollen, and byproducts of vaporization such as formaldehyde and acetaldehyde (Kim and Shin, 2013).

Cartridge refills may contain impurities, and a recent study showed that 10 of 20 e-liquids analyzed contained up to five times the maximum allowed levels of impurities (Etter et al., 2013). Currently there is no country that regulates ECIG or e-liquids as medications or drug delivery devices, so there are no manufacturing standards and no monitoring of labeling accuracy, or presence of impurities or toxic compounds. This is because ECIGs are marketed as tobacco alternatives instead of medications. E-liquids and ECIG vapor may contain a variety of toxicants, and because ECIGs may be used in ways unintended by the manufacturer (e.g., dripping, mixing solutions), this can result in exposure to even higher levels of toxicants, as well as nicotine.

Experienced ECIG users may self-administer nicotine at levels similar to tobacco cigarette smoking (Vansickel and Eissenberg, 2013). As with tobacco smoking, this may lead to development of physical dependence on nicotine in ECIGs. Consequences of ECIG use may result in fulfillment of criteria for a diagnosis of TUD. Even though data suggest that ECIGs have a lower abuse potential than tobacco cigarettes, there is still potential to develop a tobacco use disorder from regular use of ECIGs (Vansickel et al., 2012). Health-related or social consequences of ECIG use result in harm to the individual from ongoing exposure to an addictive substance.

ECIGs are a potential form of harm reduction for those who use other tobacco products, due to reduced exposure to known carcinogens and other toxicants found in tobacco products. When used as a form of pharmacotherapy for tobacco cessation, ECIGs may help to reduce harm even further if the tobacco user quits successfully. However, ECIGs should not be considered safe because nicotine itself has long-term consequences, ECIGs contain impurities, and use of nicotine leads to addiction, which can have serious consequences, especially if ECIGs users employ unorthodox methods of abusing EC.

Nicotine is a gateway drug—The gateway theory of addiction describes a sequence and progression of addictive substance use, from tobacco and alcohol to cannabis and then to other illicit drugs like heroin and cocaine (Kandel et al., 1992). Nicotine is a potent gateway drug for diverse illegal drugs (Lai et al., 2000), especially among adolescents (Rigotti et al., 2000). Whether initiating use of tobacco or ECIG, nicotine exposure may lead to use of other—more harmful or illegal—substances (DiFranza and Wellman, 2005; McMillen et al., 2012).

The woman in Case 3 had not previously used tobacco products, but found she enjoyed the effects of nicotine in ECIGs and escalated her use. As with tobacco smokers, she is at risk to progress to use of other substances after first acquiring nicotine use. Recognition of the potential for progression to other drug use can help clinicians to address nicotine use in order to prevent future harm to the individual. Fortunately, there are effective ways to address tobacco use in patients, and these can be easily adapted to address ECIG use.

Assisting patients to quit—After a clinician provides a patient with appropriate, accurate information about risks of ECIG use, some will decide to make a quit attempt. At this point, clinicians can provide brief motivational counseling to the patient, along with education about available resources to facilitate a quit attempt. Brief counseling provided by

a clinician in a healthcare setting significantly increases nicotine quit rates versus no counseling (Stead et al., 2008). There are a variety of methods available to clinicians to provide brief counseling for tobacco cessation. One of these, known as the “5 As” approach, has been endorsed by multiple sources for its brevity and effectiveness (Fiore et al., 2000).

Clinicians can counsel current EC users by using a 5 As approach (ask about tobacco use, advice to quit, assess willingness to make a quit attempt, assist in quit attempt, and arrange follow-up) (Young et al., 2010; Lawson et al., 2009). After asking about tobacco product and ECIG use as described above with Case 1, clinicians can provide clear advice to patients to quit to prevent future consequences of nicotine exposure. If the patient is willing to make a quit attempt in the near future, then the clinician can provide assistance to the patient in this attempt. This may include a discussion of the use of ECIG as pharmacotherapy to aid in the quit attempt for tobacco products, or it may involve recommendations for other NRT or pharmacotherapy (bupropion, varenicline). Clinicians can also refer patients to behavioral treatment opportunities, such as toll-free smoking telephone quitlines, online websites, smoking cessation groups, or individual therapists. In 2004, the U.S. Department of Health and Human Services (DHHS) established a national toll-free number, 800-QUIT-NOW (800-784-8669), as a single telephone quitline access point for information and assistance in quitting smoking. Callers to the number are routed to their state’s smoking cessation quitline, or to one maintained by the National Cancer Institute for states that do not have a quitline. A website (www.smokefree.gov) maintained by DHHS provides information to download to make cessation easier. As discussed above in Case 2, pharmacotherapy is made much more successful with the addition of behavioral therapy, so referral to an appropriate behavioral resource is necessary. After the initial discussion about cessation of nicotine use, clinicians should arrange for a follow-up visit with the patient, if possible, to determine whether the quit attempt was successful, or whether additional recommendations are necessary.

CONCLUSIONS

ECIGs are growing in popularity. Clinicians should be aware of how they are used and misused in order to assess patients for TUD appropriately. All patients should be asked about nicotine and tobacco use, including ECIGs. Even those who have never smoked tobacco may try ECIGs, so it is worthwhile to ask patients open-ended questions about nicotine and tobacco product use instead of only asking about cigarettes. It is important to ask about ECIG and tobacco product use among friends and family, since these can help determine the risk of escalating use of nicotine for a specific patient.

Some patients may use ECIGs as a form of NRT for assistance with tobacco smoking cessation, while others abuse ECIGs in unorthodox ways to increase the level of nicotine exposure. ECIG liquid and vapor may contain impurities and toxicants that can increase the risks of problems, especially when ECIG liquids are mixed at home, or adjustments are made to ECIGs. For those who want to quit, evidence is mixed about the ability of ECIGs to help smokers achieve long-term abstinence. Behavioral treatment with counseling and support is essential for a quit attempt to be successful.

Clinicians can assist patients to quit using nicotine with a strategy such as the 5 As approach. Providing accurate, unbiased information to patients about the benefits of ECIG (compared to other tobacco products as a form of harm reduction) and the risks of ECIG use helps patients to make informed choices about their health and lifestyle. Clear advice from a clinician to stop using nicotine has a powerful effect on patient behavior. Referral to appropriate resources to aid the patient in a quit attempt is also necessary.

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Table 1

Tobacco (nicotine) use disorder diagnostic criteria

Diagnostic criterion	Example
Problematic pattern of nicotine use leading to clinically significant impairment or distress occurring within a 12-month period	Continued use of electronic cigarettes despite recognition of consequences
Use of larger amounts or over a longer period than was intended	Vaping more than intended
Persistent desire or unsuccessful efforts to cut down or control use	Inability to cut down, resumption of vaping after a period of abstinence
A great deal of time is spent in activities necessary to obtain or use nicotine	Constant vaping; Frequent trips to ECIG retailers in person and/or online.
Craving	A strong desire or urge to use nicotine
Recurrent nicotine use resulting in a failure to fulfill major role obligations at work, school, or home	Interference with work
Continued use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of nicotine	Arguments with others about nicotine use
Important social, occupational, or recreational activities are given up or reduced because of nicotine use	Forgoes an activity because it occurs in a nicotine-use restricted area
Recurrent use in situations in which it is physically hazardous	Vaping in bed, vaping around flammable chemicals
Use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by nicotine	Continued use despite diagnosed heart or lung disease
Tolerance, as defined by either:	
a. Need for markedly increased amounts of nicotine to achieve the desired effect	Dripping, consistent use of higher voltage device
b. Markedly diminished effect with continued use of the same amount of nicotine	Disappearance of nausea and dizziness after repeated intake More intense effect of nicotine the first time it is used during the day
Withdrawal, as manifested by either:	
a. Characteristic withdrawal syndrome	Four or more of the following within 24 hours after cessation or reduction of use: Irritability, frustration, or anger Anxiety Difficulty concentrating Increased appetite Restlessness Depressed mood Insomnia
b. Nicotine is taken to relieve or avoid withdrawal symptoms	Vaping within the first 30 minutes after waking.

Severity is determined as:

Mild — presence of 2-3 criteria

Moderate — presence of 4-5 criteria

Severe — presence of 6 or more criteria

Adapted from APA, 2013