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Measuring E-Cigarette Use, Dependence, and Perceptions: Important Principles and Considerations to Advance Tobacco Regulatory Science

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Electronic nicotine delivery systems, which include electronic cigarettes (e-cigarettes), vape pens, vapes, vaporizers, e-hookah, e-pipes, and e-cigars, are a growing category of tobacco products. On the U.S. market since 2007, past 30-day use of e-cigarettes has surpassed use of conventional cigarettes, with the rate of 11.3% among high school students (8.0% for cigarettes) (Jamal, Gentzke, Hu, Cullen, Apelberg, Homa, & King, 2017; Syamlal, King, & Mazurek, 2016). In 2016, 15.4% of adults aged 18 and over had ever used e-cigarettes, with 3.2% of adults currently using e-cigarettes. Among young adults, 18–24 years old, 23.5% have ever used an e-cigarette (MMWR, 2016).

E-cigarettes aerosolize “e-liquids,” which may or may not contain nicotine. They also contain flavorings, propylene glycol, vegetable glycerin, and numerous other ingredients. E-cigarettes come in a multitude of sweet and fruity flavors (Brown, Luo, Isabelle, & Pankow, 2014), as well as mint/menthol and tobacco flavors, to name a few. While the flavors are sometimes marketed using conventional descriptors such as cherry, grape, cupcake, tobacco, or coffee, often the flavor names are more nuanced, such as churros, Grandmaster or Thug Juice (Salter, 2015), making it difficult to discern the actual flavors contained within the product. E-cigarettes also come in a plethora of nicotine concentrations, ranging from 0 mg/mL to 40 mg/mL, or 4.0%. Further, e-cigarettes come in a wide range of device types and accompanying parts and components, from the 1st generation cig-alikes that appear more like combustible cigarettes to disposable products to new later generation devices that include tanks and mods (Barrington-Trimis, Gibson, Halpern-Felsher, Harrell, Kong, Krishnan-Sarin, Leventhal, Loukas, & Weaver, 2017). The shapes and functions also vary as

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the device becomes more sophisticated. To add to the complication, the terms of these products have greatly varied as described earlier (e.g., ENDS, e-cigarettes, vape pens, e-hookah). The different e-cigarette devices also vary in their efficiency in delivering nicotine to the bloodstream (Farasalinou, Spyrou, Tsimopoulou, Stefopoulos, Romagna, & Voudris, 2014), with the newer devices tending to be more efficient. In addition, users find it easier to use e-cigarettes in their homes or public space because the vapors disappear quickly without smoke or cigarette smells. The devices are usually ready-to-use instantly; therefore, users can easily vape a few puffs on various occasions and throughout the day, sometimes without realizing how much they actually vaped (Kim, Davis, Dohack, & Clark, 2017). As such, it has been a challenge to accurately measure e-cigarette use including frequency and quantity, level of exposure to nicotine and other toxins, and perceptions of risks associated with e-cigarettes.

Given these complicated issues associated with e-cigarette products, there are specific challenges facing researchers who want to accurately measure levels of e-cigarette use, dependence and addiction, and knowledge, attitudes, and perceptions towards e-cigarettes. Simply modifying existing measures of conventional cigarette use, dependence, and knowledge, attitudes, and perceptions is insufficient. For example, there are no current standardized measures of e-cigarette use that consider: (a) different terminology that apply to users in different age groups (e.g., e-cigarettes for adults versus vape or vape pens for youth), (b) accurate descriptions of use patterns, including the number of puffs or use throughout the day; (c) measures of quantity or intensity of use; and (d) measures of nicotine or flavor consumption. Similarly, we have few validated and agreed upon measures of nicotine dependence for e-cigarettes. While many investigators have adapted measures such as the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, Fagerstrom, 1991; Pomerleau, Majchrezak, & Pomerleau, 1989) or the Hooked on Nicotine Checklist (DiFranza, Savageau, Fletcher, Ockene, Rigotti, McNeill, Coleman, & Wood, 2002), we have virtually no data to determine whether such adapted measures correctly assess nicotine dependence for e-cigarettes. In addition, while there are studies showing a relationship between perceptions of risks and benefits and cigarette use (e.g., Cengelli, O'Loughlin, Lauzon, & Cornuz, 2012; Costello, Logel, Fong, Zanna, & McDonald, 2012; Romer & Jamieson, 2001; Song, A. V., Morrell, H. E. R., Cornell, J. L., Ramos, M. E., Biehl, M., Kropp, R. Y., & Halpern-Felsher, 2009), we have limited information to inform what attitudes and perceptions concerning e-cigarettes and other newer products are important to measure. Having more standardized measures will allow for a more uniform set of measures that can be used across studies, thus yielding findings that can be comparable to inform regulatory science and policy.

To address these concerns and the current lack of standardized measures of self-reported e-cigarette use, dependence, and knowledge, attitudes, and perceptions, members of the Tobacco Centers of Regulatory Science (TCORS) Work Group came together to develop a set of three review papers for consensus measures on e-cigarette use, dependence, and perceptions. Through in-person and teleconference meetings, as well as email correspondence, each of the three subgroups focused on reviewing current measures related to each domain. The ultimate goal is to provide a set of principles and considerations that can be used in future studies of self-reported e-cigarette product use, dependence, and

perceptions and share them within and outside of the TCORS projects. The first paper, “Establishing Consensus on Survey Measures for Electronic Nicotine and Non-Nicotine Delivery System Use: Current Challenges and Considerations for Researchers” focuses on measures of e-cigarette use such as device characteristics, current use, and frequency and quantity (Weaver, Kim, Glasser, Sutfin, Barrington-Trimis, Payne, Saddleson, & Loukas, In Press). The second paper, “Measuring E-cigarette Dependence: Initial Guidance,” reviews constructs that may be important to consider for developing a measure of e-cigarette dependence (Bold, Sussman, O’Malley, Grana, Foulds, Fishbein, & Krishnan-Sarin, In Press). The third paper, “Measuring Perceptions Related to E-cigarettes: Important Principles and Next Steps to Enhance Study Validity” focuses on measures concerning perceptions of benefits, harm perceptions, addiction perceptions, and perceptions of social norms (Gibson, Creamer, Breland, Giachello, Kaufman, Kong, Pechacek, Pepper, Soule, & Halpern-Felsher, In Press). Across all three papers and types of measures, it is clearly suggested that valid e-cigarette measures should explicitly state what terminology is used when referring to e-cigarettes, what types of e-cigarette device are used (either by using pictures and descriptions within the survey), whether nicotine is used in the e-liquid, and whether flavors are used in the e-liquid. As well, it is important to clearly describe what target populations the measures are intended for in terms of age of the study participants (e.g., youth or adults), and whether participants are new or established users, or solely e-cigarette users or dual/poly users with other tobacco products.

As the US Food and Drug Administration (FDA) has the legal authority to regulate e-cigarettes, it is imperative for researchers to develop consensus e-cigarette measures. Such accomplishment is a fundamental step toward the development of the FDA’s regulatory framework involving e-cigarettes. The three papers presented in this special section summarize the current state of consensus measures in the areas of self-reported e-cigarette use, dependence, and perceptions, and inform future efforts to further validate those consensus measures.

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Highlights

- E-cigarettes are complex, and thus measuring use, dependence, and perceptions related to these products is also complex
- Needed are more standardized measures related to e-cigarettes
- This paper highlights 3 papers providing guidance on e-cigarette-related measures