Cross Sectional Survey

Electronic Cigarette (E-Cig) Use in the Chronic Pain Population

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Background: Since electronic cigarettes (E-Cigs) were introduced to the United States (US) in 2007 its use has increased. Like other tobacco products, E-Cigs too pose health risks. Studies have shown a correlation between pain and tobacco use, with the association being bidirectional. However, there is limited data on the effect of E-Cig use on chronic pain, as well as its association with opioid use.

Objectives: To evaluate the use of tobacco products, including E-Cigs in a chronic pain population.

Study Design: This study was designed as a cross sectional survey.

Setting: This study was set in an urban academic teaching center.

Methods: After IRB approval, surveys of established chronic pain patients were conducted over 4 months. The survey and results were anonymous, without the collection of any identifiable information. The adult patients who had been treated in the pain practice for over 3 months were included in this study. The survey collected the patients' age, gender, history of tobacco usage, cigarette smoking, E-Cig and opioid use.

Results: A total of 312 patients were surveyed. 198 women (63.5%) and 114 men (36.5%). The average age was 58.2; ~59 years for men and ~58 years for women. Eighty-four patients (26.9%) were managing pain using chronic opioids; 46 women and 38 men. Nine women (4.5%) had tried E-Cigs in the past, but none (0%) were active users. Eighteen men (15.8%) had tried E-Cigs in the past with 9 (7.8%) being active users. Among the opioid managed patients, 6 (9.1%) had and were active users of E-Cigs and all 6 were men (20%).

Limitations: The anonymous results collected through the survey may not be accurate as they cannot be validated. In addition to the small sample size, the entire study population is from an urban academic center which may not be generalizable to all chronic pain patients. Finally, the study does not evaluate the impact of tobacco or E-Cig use on pain level or functional status.

Conclusion: In this study of chronic pain patients, cigarette smoking and E-Cig use was similar to the reported use in the general adult population in the US. The study showed a strong correlation between tobacco use, especially cigarettes and E-Cigs, and opioid use. As the use of E-Cigs becomes more mainstream, the association between E-Cig use, chronic pain, and opioid use should be monitored.

Key words: Tobacco use, electronic cigarettes, E-Cig, E-cigarette, opioid use, chronic pain

IRB: Institutional IRB approval (#00000319)

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Ever since electronic cigarettes (E-Cigs) were first introduced to the United States (US) in 2007, they have been widely used, particularly by the youth and young adults (1). The prevalence of E-Cig use in adults in the US was estimated to be ~11.1 million (4.5%) in 2021 (2). From 2020-2022, the overall sales

of E-Cigs have increased by 46.6% (2). Although there is limited and conflicting evidence for E-Cig being a smoking cessation aid, many adults use E-Cig to try to attempt to quit smoking (3). Others use E-Cigs as a substitute for cigarettes in locations where smoking is not allowed. Like all other tobacco products, E-Cigs commonly contain high concentrations of nicotine and as a result, pose similar health risks.

Studies have shown a correlation between tobacco use, especially in the form of cigarette smoking, and pain, anxiety and depression. The associations are bidirectional: cigarette smoking is associated with higher pain, anxiety, and depression levels; and chronic pain, anxiety and depression are associated with increased cigarette smoking (4,5). Additionally, cigarette smoking is associated with cravings, further impacting those with anxiety and chronic pain (6,7). While tobacco is commonly used for coping with chronic pain, the nicotine in tobacco also has the potential benefit of acting as an acute analgesic effect (8,9). Unsurprisingly, a recent study suggested that cigarette smokers with chronic pain are more likely to report the use of E-Cigs (10). However, there is limited data on E-cig use in patients with chronic pain, as well as its association with opioid use.

This study utilized an anonymous survey of chronic pain patients to assess the use of tobacco products, including cigarettes and E-Cigs, to better understand and evaluate any correlation.

Methods

After IRB approval (#00000319), surveys of established chronic pain patients were conducted at an urban academic medical center over 4 months. The survey and results were anonymous, and no identifiable information was collected. Patients, over the age of 18, receiving treatment under the pain practice for over 3 months were included in this study. All patients were provided with information and instructions for voluntary participation. Those interested were given a non-return memo and then surveyed by an independent staff member. The research members who reviewed the data were not involved in the survey collection.

The survey collected the age, gender, information on tobacco, cigarette smoking, E-Cig and opioid use of patients. All analyses were performed using R Statistical software (R Core Team). The Welch Two Sample t-test was performed for the calculation of correlation and significance. The results were considered significant if they had a *P*-value of less and or equal to 0.05.

Results

A total of 312 patients were surveyed: 198 women (63.5%) and 114 men (36.5%). The average age was 58.2: ~59 years for men and ~58 years for women (Table 1). Nine women (4.5%) had used E-Cigs in the past, but none (0%) were active users. Eighteen men (15.8%) had used E-Cigs in the past with 9 (7.8%) being active users. Eighty-four patients (26.9%) managed pain with chronic opioids: 46 women, 38 men. Among the opioid managed patients, 6 (9.1%) were active users of E-Cigs, and they were all men (20%).

Patients on chronic opioid treatment are more likely to report having smoked cigarettes ($P = 0.043$) than those not taking opioids (Table 2). Patients who report having smoked E-Cigs are more likely to report using tobacco products ($P = 0.003$), having smoked cigarettes ($P = 0.002$), and currently smoking cigarettes ($P = 0.002$) than those who have never used E-Cigs (Table 3). Finally, patients who report having smoked cigarettes are more likely to report using tobacco products ($P < 0.001$) and report having used E-Cigs ($P = 0.002$) than those who do not report having smoked cigarettes (Table 4). Additionally, patients who report having smoked cigarettes are more likely to be men.

Discussion

E-Cigs are an electronic nicotine delivery system that mimics tobacco smoking without the combustion of tobacco (11). E-Cigs have been marketed as a less harmful alternative to traditional tobacco smoking and its use has increased since its initial availability in the US, and even more significantly since 2010 (12). E-Cigs have also been marketed to help quit smoking by satisfying cravings for nicotine and to prevent non-smokers from starting to smoke cigarettes (13). Due to the lack of extensive testing or long-term safety trials, their effectiveness as a cigarette smoking prevention or cessation intervention, and their safety compared to traditional tobacco smoking is still a controversy (14).

The acceleration of E-Cig use is similar to that of traditional cigarettes. Cigarette use significantly increased in the late 19th and early 20th century with the growth of mass production technologies and advertising (15). However, until the 1930s, the associated health concerns remained unnoticed, and only in the 1960's did the US Surgeon General attribute lung cancer to cigarette smoking (16,17). E-Cigs use a metal resistance coil to heat and aerosolize a liquid mixture containing nicotine. Since its initial introduction, E-Cigs

have undergone major design changes to allow greater control of the mixture composition, nicotine concentration and the aerosolization process.

Tobacco use has long been associated with pain (18,19). Those with more severe nicotine dependence experience greater pain intensity and pain interference with functioning. Additionally, the co-morbidity and association of pain and tobacco use, including cigarette smoking, is bidirectional (6,7,19). As a result, pain and tobacco use may negatively affect each other, by reducing the likelihood of successful smoking cessation and pain treatment (20).

Ongoing and past use of tobacco has also been associated with the development of chronic pain and opioid use (21-23). Nicotine has an analgesic effect, but with chronic exposure, a tolerance can develop, reducing its analgesic effect (8,9,24). Nicotine also affects the endogenous opioid system and chronic exposure may affect the processing of nociceptive stimuli (25). Studies have shown that increased tobacco use results in a greater risk of requiring opioids to treat physical pain (26,27). Smokers use cigarettes to self-medicate but with the evidence showing cross-tolerance between nicotine and opioids, this behavior may be self-limiting, and ultimately be more harmful (28).

With the growing popularity of E-Cig use as another form of nicotine delivery, studies have started to explore associations between chronic pain and E-Cig use (4). One study surveyed established chronic pain patients on their use of tobacco products including cigarettes and E-Cigs. Overall, ~30% of the patients reported currently using cigarettes compared to 3.8% who were currently using E-Cigs. Both rates are similar to the overall reported rate in the US, which are 29.4% and 4.5%, respectively. Although, the amount of those who had used cigarettes in the past were higher (~53%) than national reports (~40%) (29). However, the study population had an average of age 58 years, which may explain the slightly lower rates since E-Cig use is more prevalent in younger adults (30).

This study showed that patients on chronic opioid medications were more likely to report having smoked cigarettes than those not on opioids. Additionally, correlation was found in E-Cig use to past and current cigarette smoking. Concurrent active E-cig and cigarette smoking was also found to be common. Finally, more males were likely to have smoked cigarettes in the past, used tobacco products in the past as well as have used E-cig.

Table 1. *Overall survey results.*

Age (Mean)	58 years (14 SD)
Age (Median)	59 years (50,69 IQR)
Gender (Women)	198 (63.5%)
Gender (Men)	114 (36.5%)
Current Opioid Use	84 (26.9%)
History of Tobacco Use	174 (55.8%)
History of Cigarette Use	165 (52.9%)
Current Cigarette Use	94 (30.1%)
History of E-Cig Use	33 (10.5%)
Current E-Cig Use	12 (3.8%)

Table 2. *Tobacco and Opioid Use.*

	***P* Value**	**95% CI**
Age	0.7	-4.6, 6.3
Gender	> 0.9	-23%, 21%
Tobacco history	0.043	-47%, -2.2%
Cigarette history	0.14	-42%, 4.6%
Current cigarette use	0.2	-35%, 8%
E-cig history	0.6	-22%, 11%
Current E-Cig	0.6	-17%, 7.8%

Table 3. *Current E-Cig Use and Tobacco Use.*

	***P* Value**
Age	0.3
Gender	0.3
Tobacco history	0.003
Opioid use	0.6
Cigarette history	0.002
Current cigarette use	0.002

Table 4. *Current Cigarette Smoking and E-Cig Use.*

	***P* Value**
Age	0.5
Gender	0.032
Tobacco history	< 0.001
Opioid use	0.14
E-Cig history	0.002
Current E-Cig use	0.13

Limitations

There are several important limitations to this study. The first is the anonymous nature of the study due to which data collected through the survey cannot be validated, so its accuracy is hard to determine. Secondly, the sample size of this study is small and the entire study population is from an urban academic

center which may not be generalizable to all chronic pain patients. Finally, the study does not evaluate the impact of tobacco or E-Cig use on pain level or functional status.

Conclusion

In this study of chronic pain patients, cigarette smoking and E-Cig use was similar to the reported use among the general adult population of the US. The study showed a strong correlation between tobacco use, especially cigarettes and E-Cigs, and opioid use. In the past, the use of tobacco products has been linked to chronic pain and increased opioid use. Similarly, as the use of E-Cig becomes more mainstream, particularly as young adults age, the correlation between E-Cig use, chronic pain and opioid use should be monitored.

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