



Efficacy of E-Cigarettes in Sustained Smoking Cessation Compared to Other Available Treatment Modalities - A Narrative Review



Vikram Valia¹ and Asmita Nene²

¹Medical student, Medical University of the Americas

²Associate Professor Physiology, Medical University of the Americas

Submission: July 13, 2023; Published: August 02, 2023

*Corresponding author: Vikram Valia, Medical student, Medical University of the Americas

Abstract

E-cigarettes are not more effective than traditional smoking cessation methods in achieving abstinence from nicotine. This is a Literature Review of current comparative studies regarding the efficacy of e-cigarette use in the cessation of smoking with other treatment. The literature search began by using Pubmed, using keywords such as "e-cigarettes AND smoking cessation." The original criteria for these first articles were how many participants were included, whether a randomized clinical trial was utilized, and how rigorous the evaluation criteria was. Next, looking through the references in a higher quality study led to obtaining a recent comprehensive review of the use of electronic cigarettes by Hartmann-Boyce et al. This resource proved to be an encyclopedia of research into electronic cigarettes, citing nearly every major article published on the use of electronic cigarette use to stop smoking. After looking up several of the studies used in the paper in Pubmed through an author search, a few related studies suggested by Pubmed were also read. The results showed statistical significance for a higher efficacy of nicotine e-cigarettes when compared to nicotine replacement treatments (NRT). It also showed higher efficacy of e-cigarettes when compared to behavioral treatment or no treatment at all. Likewise, nicotine e-cigarettes showed higher efficacy than non-nicotine cigarettes. E-cigarettes were less efficient than monetary reward and varenicline. It will be helpful for current smokers if more research is aimed at realizing effective ways to incorporate nicotine e-cigarettes in smoking cessation plans for both motivated and unmotivated smokers.

Keywords: NRT; Refillable; Placebo; Stop-Smoking Services

Introduction and Background

This paper will address the efficacy of e-cigarettes in smoking cessation compared to other methods. E-cigarettes commonly used in studies are generally divided into two types, non-nicotine and nicotine containing. Non-nicotine e-cigarettes may also be referred to as placebo e-cigarettes in certain studies. A secondary distinction is sometimes made between 1st and 2nd generation e-cigarettes as well. The first generation of e-cigarettes utilized cartridges and had a comparatively minimal amount of nicotine delivered to the blood. The second generation may be referred to as "refillable" e-cigarettes, in which the user uses an "e-liquid. This type of e-cigarette can provide more nicotine to the user, as well as a variety of flavors Baldasari 2017. There is a third generation as well, where the smoker can manually adjust the power on the device, as well as a newer pod design, common in the United States with the ubiquitous Juul brand. The latter two designs are not well studied for their effect on smoking cessation yet Hartmann-Boyce et al. [1].

In a few studies, even non-nicotine cigarettes have benefited patients trying to quit. It is thought that a significant part of what

drives smokers to combustible cigarettes is the mechanical action of smoking itself; in tandem with muscle memory. Conversely, intravenous nicotine, though able to raise blood nicotine levels at equally fast rates as smoking cigarettes, has not been found to be a strong smoking deterrent. Another form of this "mechanical" motivation is the scratch of smoke felt at the back of the smoker's throat. It is hypothesized that this is why substances such as citric acid has been shown to have a positive effect on smokers Hartmann-Boyce et al. [1]. E-cigarettes can provide these environmental cues to the smokers; they are able to produce similar throat sensation and have a taste, the vapor that the user puffs out may provide a psychologically satisfying simulation of actual smoke Hartmann-Boyce et al. [1].

E-cigarettes are popular with the public. In Great Britain, almost one out of five adults have reported trying an e-cigarette and in the United States, one out of twenty-five adults currently smoke e-cigarettes. Use has been on the rise since the introduction to these countries and others as well. E-cigarette studies have been done not only in the U.S. and Britain, but also Canada, Italy, New

Zealand, Finland and many other countries. With this popularity comes legitimate public health concern about the appeal of this technology to children. Countries such as the United States have responded by enacting a ban of certain flavors that may appeal to them. Still, one out of fifteen children between 16 and 19 use e-cigarettes on most days of the week. Prevention of inadvertent online e-cigarette sales to minors may also pose a problem. In the last several years, the advent of the “high nicotine delivery device” Juul is thought to have increased use in children Vallone [2]. These problems lie outside the scope of this paper. Epidemiologically, there have not been many studies to determine what percentage of non-smokers that have used e-cigarettes to quit. Perhaps this may be an area of future research.

A few studies have been conducted. It was found that 9.1% of non-smokers had relied solely on some form of e-cigarettes to quit Patel [3]. This provides a reason to look further into whether e-cigarettes are an effective smoking cessation method. Though one might assume that many non-smokers would use nicotine patches, gums, or other traditional nicotine replacement therapies (NRT’s) due to their ubiquitous nature; the same survey found that only 21.2% used either e-cigarettes or some form of NRT. Older studies have found that e-cigarettes were more popular in attempting to quit than any type of pharmacological treatment, perhaps due to their unique ability to provide nicotine via a familiar type of delivery system for smokers Pearce [4].

It is also worth exploring whether e-cigarettes can be used as a reduction of harm method regarding traditional cardiovascular health measures, as well as limiting certain non-nicotine toxins in the body. It is known, for example, that combustible cigarettes harden arteries over time and place great stress on the cardiovascular system. Would e-cigarette users suffer less of these problems than smokers in a randomized clinical trial Ikonomidis [5]? Biomarkers of non-nicotine toxins have been measured both over a few days of abstinence from smoking Jay [6] and a more clinically significant amount of time Pulvers [7].

E-cigarettes have also been compared to monetary reward to measure comparative effectiveness Halpern [8]. Also, behavioural support and/or no treatment have been compared in several studies Walele 2018. Among populations with mental health and drug addiction, cigarette smoking is often a comorbidity Comanetto [9]. This provides another appeal to research on whether e-cigarettes are effective. In severe mental illness, an important question becomes whether e-cigarettes are a more pleasurable way to quit than traditional methods Comanetto [9]. The term quitting is not something that can be objectively defined in experimental settings. A reasonable ideal is 6 months of abstinence from combustible cigarettes. It is thought that the benefits of quitting smoking outweigh those of just reducing the number of cigarettes smoked, which is why so many of the studies done in the last 10 years focus on the use of e-cigarettes for smoking cessation Hartmann-Boyce [1].

Methods

The literature search began by inputting keywords into Pubmed such as “e-cigarettes AND smoking cessation”. The original criteria in analyzing the strength of these articles consisted of how many participants were included, whether a randomized clinical trial was utilized, and how rigorous the evaluation criteria was. If multiple criteria were used, the research was considered a higher quality study. Particular study populations were given preference. Because research on e-cigarettes as a smoking cessation tool is still in early stages, high quality research is not in abundance. However, this is changing in recent years and there may be renewed interest with the increase in popularity of newer, high nicotine content pod-style e-cigarettes such as the JUUL brand Fodus [10].

The second search for articles stemmed from looking through the references of one of the higher quality studies initially obtained. Searching through the references in Hajek et al’s New England Journal of Medicine study on comparing e-cigarettes and traditional nicotine replacement therapies led to obtaining a recent comprehensive review of the use of electronic cigarettes by Hartmann-Boyce et al. The review was originally published in 2014, updated in 2016 and again in October of 2020. This resource proved to be an encyclopedia of research into electronic cigarettes, citing nearly every major article published on the use of electronic cigarette use to stop smoking. After looking up several of the studies used in this compendium through a Pubmed author search, a few related studies suggested by Pubmed were also read.

The articles in the initial search provide a fairly representative sample of the general topics addressed in this review. As such, a table with conclusions and brief descriptions of the research is included in the appendix, along with design of study and perceived strength of the study. This provides a sample of how the data was approached moving forward into the second search. There are several major criteria that are used to divide and group studies on e-cigarette use for smoking cessation. Taken from the Hartmann-Boyce et al review, they are summarized in the following paragraphs. The type of subjects that are selected are people who actively smoke combustible cigarettes. Some studies use smokers who are “motivated” to quit, while others use smokers who are not motiva.

The most important and recurrent form of comparison are as follows. Evaluating results based on electronic cigarettes versus nicotine replacement therapies (NRT) such as nicotine patches and nicotine gum is paramount, as NRT has been the standard of care for decades. Other areas of comparison have proven to also be of interest to researchers. For example, evaluating electronic cigarettes versus receiving no therapy or behavioral therapy has been examined. Also, electronic cigarettes in combination with NRT and/or behavioral therapy have been analyzed. And rarely, nicotine and non-nicotine “placebo” electronic cigarettes have been compared.

The main outcome most commonly measured is smoking cessation, ideally six months after the start of the study. Many of the studies also try to evaluate adverse effects from any of the therapies used, along with a comparison of the adverse effects from combustible cigarettes. Preferably, smoking cessation is not measured in the studies by subjective means, but objectively by means such as expired carbon monoxide (eCO). Expired CO along with other measures of health, though not as important as abstaining from cigarettes, are measures of interest in some of the studies. Comparing toxic substances once a smoker has completely switched to e-cigarettes or NRT was the most measured metric, but others such as lung spirometry measures were of interest Hartmann-Boyce et al. [1]. The target population was varied and not used as criteria to group studies, but different populations were noted, such as smokers suffering from schizophrenia, mental illness, opioid disorders, or simply populations of different countries.

Results

The three main areas of comparison in the efficacy in smoking cessation, according to Hartmann-Boyce et al, are comparing nicotine electronic cigarettes to NRT, comparing nicotine and non-nicotine electronic cigarettes, and comparing nicotine electronic cigarettes to behavioral therapy or no therapy Hartmann Boyce et al. [1]. Two others that are briefly mentioned in this review

compare e-cigarettes to potent pharmacotherapy, namely varenicline; and comparing the efficacy of cigarettes to monetary incentives. The primary comparison is that of nicotine electronic cigarettes and NRT. Nicotine patches, gums and lozenges are included in this group. To this review, prescription medications such as varenicline will be assessed separately. Hartmann-Boyce et al. [1] analyzed the results from three separate studies and combined the data to get statistical information on whether e-cigarettes or NRT are more likely to lead to smoking cessation.

The result of this analysis (see the attached (Table 1) taken directly from their database), was that they found a statistically significant increase in the relative risk of quitting smoking for subjects treated with electronic cigarettes over those treated with NRT. For every 100 subjects, 6 using NRT could be expected to abstain from smoking cigarettes, while with 10 out of every 100 using e-cigarettes, abstinence could be expected. This lead to a relative risk of 1.69 with a 95% confidence interval of 1.27 to 2.27. Among the three randomized control trials, there were 1498 subjects. The first study used Bullen [11] was a randomized control trial in New Zealand done over 18 months. The smokers, who were motivated to quit, were given either nicotine e-cigarettes, NRT, or non-nicotine e-cigarettes. Of the 657 selected, for every four subjects given nicotine cigarettes, four were given NRT, and one control was given the placebo non-nicotine cigarettes.

Table 1: Appendix: Sample Methods.

First Author	Date of Publication	Study Design	Level of Evidence	Study Population	Therapy or Exposure	Outcome/Results
Benowitz, N. L.	[1]	RCT	2	Smokers	Nicotine patches and e-cigarettes containing nicotine.	Dual therapy with nicotine patches and nicotine containing e-cigarettes have higher efficacy in smoking cessation (7% over 6 months) than nicotine patches and non-tobacco containing e-cigarettes (4%)
Brown, J., Beard	[2]	Cross Sectional Survey	3	5863 English Smokers who had previously made at least one attempt to quit, had bought a nicotine replacement therapy (nrt) product, or smoked at least one cigarette in the last 12 months.	Over the counter nicotine replacement therapy and e-cigarettes.	The odds of quitting smoking were 1.63 times higher in subjects who used e-cigarettes than those who used NRTs. Odds were adjusted for factors such as nicotine dependence
Hajek, P., New England Journal of Medicine	[14]	RCT	4	886 English Smokers	NRT, e-cigarettes. Behavioral therapy provided to all subjects.	E-cigarette users had higher abstinence from cigarettes at the end of one year (18% vs 9.9%) but, out of those that maintained abstinence, a higher proportion of e-cigarette users were still dependent on nicotine (80% vs 9%)
Frank, A. S.	[9]	Literature Review	1	Smokers	E-cigarettes	E-cigarettes were not an effective smoking cessation tool for cancer patients. For patients with mental health issues
Ghosh, S.	[10]	Literature Review (4 RCT and "several" cohort studies)	3	British smokers	E-cigarettes and NRT	Smoking cessation is most likely when E-cigarettes are combined with NRT, such as varenicline. Studies were done on too small of a scale to be conclusive.

Golden-son, N. I.	[11]	Prospective Cohort Study	5	High School E-cigarette users	E-cigarettes with nicotine and cigarettes.	The increase in odds of a 10th grade e-cigarette user progressing to smoking cigarettes at a 6-month follow-up was 2.26 with a 95% Confidence Interval.
Halpern, S. D.	[13]	RCT	5	6000 smokers	Monetary incentives, motivational text messages, e-cigarettes	e-cigarettes were not more effective than conventional motivational therapy and less effective than monetary incentives.
Lee, S.	[19]	RCT	5	Smokers (veterans) scheduled to undergo a surgical procedure	e-cigarettes and nicotine patches (control)	Smokers scheduled to undergo a surgical procedure who were given e-cigarettes showed a significant increase in FEV1 (40.1 percent)
Li, J.	[20]	RCT	3	886 British Smokers	e-cigarettes vs nrt (control)	E-cigarettes were shown to be more cost effective than NRT.
Malas, M.	[23]	Literature Review	3	2855 References	e-cigarettes	E-cigarettes can reduce withdrawal symptoms and have a low effect on reducing cigarette usage.
Rahman, M. A.	[27]	Literature Review	2	6 studies involving 7,551 participants	e-cigarettes, both with and without nicotine	E-cigarettes with nicotine were more effective at reducing the number of cigarettes smoked than those without.
Zborovskaya, Y.	[30]	Literature Review	1	"Integrative Review" (?)	e-cigarettes	E-cigarettes were not found to be an effective means for smoking cessation but were found to be less harmful than cigarettes.

They were first introduced to the treatment one week before quitting and continued having access to the treatment for 12 weeks after the designated date of smoking cessation. Both groups were able to utilize telephone counseling as a behavioural adjunct. The desired outcome was complete smoking cessation 6 months after the designated date, measured through expired CO levels. After 6 months, 7.3% of the e-cigarette group, 21 subjects in total, had eCO levels indicative of complete cessation. Among the group given the NRT, which were nicotine patches, 5.8% had ceased smoking. Among the non-nicotine e-cigarette group, 4.1%, or 3 people, had quit smoking. This was calculated by the researchers to be a 1.51 relative risk of quitting smoking using nicotine electronic cigarettes over NRT, with a very wide confidence interval. Regardless, they concluded that there was evidence of e-cigarettes having a moderate effect on quitting smoking, with a similar efficacy as nicotine patches.

It could not be stated with statistical significance by the authors as to whether nicotine or non-nicotine e-cigarettes were more effective. The second study combined to generate data on comparing the efficacy of e-cigarettes and NRT was by Hajek et al. [12] comparing e-cigarettes and NRT among British adult smokers selected from British National Health Service "stop-smoking services". The study used 886 people and divided them into two cohorts. One which were given either a single type of NRT or a combination of multiple products, and the second which were given a 2nd generation refillable nicotine e-cigarette "starter pack" with e-cigarette liquid containing 18 mg nicotine per milliliter, a

medium dose slightly under the British maximum limit of 20 mg/militer. For comparison, the JUUL brand has over 50 mg of nicotine per milliliter in the United States.

These treatments were combined with behavioral therapy, and the stated target was one year of smoking cessation. Of the 886 smokers, 18.0% of the e-cigarette cohort completely refrained from cigarettes at the 1 year mark, as measured by eCO levels. This was also true of 9.9% of the NRT group, resulting in a statistically significant relative risk of 1.83, with a 95% confidence level of 1.30 to 2.58 and a p value < .001. As with other studies, the Hajek study found adherence to e-cigarettes to be higher than other forms of treatment. 80% of e-cigarette users were still using the devices at the end of the follow-up period, while the same could be said of only 9% of the nicotine replacement therapy group. In a third study, Lee [13] pre-surgery patients were given either e-cigarettes or nicotine patches (NRT) to see if the treatment would induce temporary abstinence of combustible cigarettes before the surgery. This was in an attempt to reduce surgical complications associated with smoking. 10 patients were given nicotine patches and 20 were given 1st generation nicotine e-cigarettes, known as Cig-a-likes. This rudimentary, older form of e-cigarette has much lower nicotine delivery rates than modern varieties.

Both groups were given a six week supply of their treatment with counseling, a brochure, and the number of a smokers' helpline. The target was measurable smoking cessation the day of the surgery, using eCO levels. On the day of the surgery, two individuals from the nicotine patch group and three from

the e-cigarette group were found to have satisfactorily stopped smoking. Though the study did not have much statistical power, the conclusion was that e-cigarettes may be used as a tool for smoking cessation in this population. All three of the studies produced data on the comparative levels of adverse effects of the two treatment modalities. Though of questionable statistical significance, the gross number of adverse effects were roughly equal between NRTs and nicotine e-cigarettes and did not represent a large portion of the pooled sample size Hartmann-Boyce [1]. Most notably, nausea was more common in subjects using traditional NRT, while among e-cigarette users, minor complaints of throat problems were more likely Hajek et al. [12].

Briefly, a few other values, though not having statistical power, are worthy of mentioning. Carbon monoxide levels are found to be less in subjects given electronic cigarettes, suggesting a lower rate of combustible cigarette smoking Hatsukami [14]. This was found in a study by Hatsumaki et al, analyzing biomarkers of toxic substances in e-cigarette users suffering from schizophrenia compared to NRT users of the same population. Data was collected

continuously, at two-week intervals. The authors felt that there may be evidence of comparatively improved FEV1 levels in e-cigarette users as well, but this lacked statistical power Hatsukami [14].

The next area of comparison may be considered a subset of the comparison of nicotine e-cigarettes and NRT. Traditionally, studies use the latter term to describe nicotine patches, nicotine gum, or something similar. Pharmacological modalities, such as varenicline, also prove to be popularly prescribed by health care professionals. One notable randomized controlled trial was done in acute coronary syndrome patients. It showed smoking cessation at 6 months, when utilizing three months of varenicline doses to be 47.3%, as reported by the patient. In a second arm of the study, patients were given nicotine e-cigarettes and 16.5% reported abstinence at 6 months. This is illustrated by the (Figure 1) used by the authors and included in the (Figure 2) attached at the end of this literature review. At all three measured points, one month, three months, and six months, the varenicline cohort reported higher rates of non-smoking. Both arms consisted of 27 patients Loakeimidis [5].

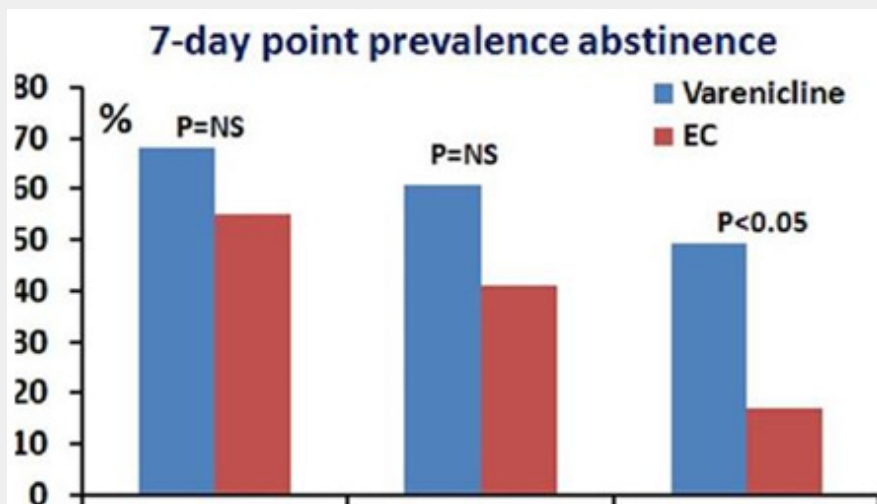


Figure 1: loakeimidis [21] Efficacy of Varenicline compared to electronic cigarettes.

All patients in the study had been smokers consuming more than 10 cigarettes per day. On average, patients had suffered an acute coronary syndrome incident requiring hospitalization 6 months prior, with a standard deviation of 2.7 months. All were motivated to quit. Both arms of the study received supplementary counseling along with treatment. The authors of the paper claim that no serious adverse effects were reported in the 3 months of use of either treatment modality. Varenicline is known to be associated with significant side effects, however Castellini 2020 such as vivid dreams, less sleep and constipation. The study shows that varenicline may be a more effective smoking cessation tool

than nicotine e-cigarettes, particularly in patient populations with a strong motivator to quit, such as those who experience an acute coronary syndrome. The next area of comparison analyzed is nicotine versus non-nicotine e-cigarettes. As non-nicotine e-cigarettes are often considered a placebo in studies, there is not as much data or conclusive findings in this area Hartmann-Boyce [1]. When combining three studies, The Hartmann-Boyce review showed a 1.71 risk ratio for quitting combustible cigarettes using nicotine e-cigarettes versus using non nicotine e-cigarettes. There is a wide 95% confidence interval, and the possibility of no effect lies just within the interval {1.00,2.92}.

SUMMARY OF FINDINGS

Summary of findings 1. Nicotine EC compared to NRT for smoking cessation

Nicotine EC compared to NRT for smoking cessation

Patient or population: People who smoke
Setting: New Zealand, UK, USA
Intervention: Nicotine EC
Comparison: NRT

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	N ^o of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with NRT	Risk with Nicotine EC				
Smoking cessation at 6 months to 1 year	Study population		RR 1.69 (1.25 to 2.27)	1498 (3 RCTs)	⊕⊕⊕⊕ MODERATE [Ⓟ]	-
Assessed with biochemical validation	6 per 100	10 per 100 (8 to 14)				
Adverse events at 4 weeks to 6 months	Study population		RR 0.98 (0.80 to 1.19)	485 (2 RCTs)	⊕⊕⊕⊕ LOW [Ⓟ]	-
Assessed by self-report	45 per 100	44 per 100 (36 to 53)				
Serious adverse events at 4 weeks to 1 year	Study population		RR 1.37 (0.77 to 2.41)	727 (2 RCTs)	⊕⊕⊕⊕ LOW [Ⓟ]	-
Assessed via self-report and medical records	5 per 100	7 per 100 (4 to 13)				

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). For cessation, the assumed risk in the control group is based on assumed quit rates for NRT assuming receipt of limited behavioural stop-smoking support (as per Hartmann-Boyce 2015a). The assumed risk for adverse events and serious adverse events is a weighted mean average of quit rates across control groups in contributing studies.

CI: Confidence interval; RCT: randomised controlled trial; RR: Risk ratio

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Figure 2: Hartmann-Boyce et al. [15].

The reasoning given for this is that the study that provides the most subjects, and thus the most weight, had a higher risk of bias. Once that study is removed or adjusted for, the risk ratio very strongly supports that nicotine e-cigarettes are more likely than non-nicotine e-cigarettes to aid smoking cessation Hartmann-Boyce [1]. In all, 802 subjects were included between the studies, 559 given nicotine e-cigarettes and 243 given non-nicotine cigarettes. Smoking abstinence rates were 10% and 7.5% respectively. The first study used was the same Bullen study mentioned previously, comparing the efficacy of nicotine e-cigarettes versus NRT. As mentioned previously, the ratio of non-nicotine e-cigarettes to NRT to nicotine e-cigarettes was 4:4:1. So for every four subjects given nicotine e-cigarettes, one was given non nicotine e-cigarettes. The study found that nicotine e-cigarettes led to a 3-fold increase in the likelihood that the subject would be abstinent from combustible cigarettes over non nicotine e-cigarettes, a relative risk of 3.16 in favor of nicotine cigarettes.

However, because of the paucity of subjects given the placebo non-nicotine e-cigarettes, the 95% confidence interval does include no effect Bullen [11]. Only 3 out of the 73 given non-nicotine e-cigarettes were able to abstain, while 21 out of 289 given electronic e-cigarettes were able to do the same. The next study included Caponnetto [9] 3 arms of 100 Italian adults each, all motivated to stop smoking. It was a 1-year randomized control trial that measured combustible cigarette use at 9 points during the year through eCO levels. Two of the arms were given nicotine

e-cigarettes. In one of the arms, the smokers were given 7.2 mg nicotine cartridges, while in the other, they were given the original cartridge for 6 weeks and then switched to a lower 5.4 mg dose for the next 6 weeks. The study found no statistically significant difference in the dosage on abstinence rates.

Between the 200 smokers in these two groups, 22 were able to achieve abstinence. In the third arm, smokers were given non-nicotine e-cigarettes for the full 12 weeks. Here, the abstinence rate was lowered to 4 out of 100. Though there was an absolute risk reduction of 7% between nicotinandnonnicotine e-cigarette groups, perhaps due to the small sample size, the study acknowledged that all three groups achieved some level of abstinence and that e-cigarettes may be an effective smoking cessation tool Caponnetto [9]. In this context, however, the absolute risk reduction seems of interest and seems to point out that nicotine e-cigarettes are more effective than the non-nicotine variety.

The last study pooled was designed primarily to assess the effect of e-cigarettes on pulmonary health when used as a replacement for combustible cigarettes. 70 subjects were placed in the non-nicotine e-cigarette arm, seventy were placed in the nicotine e-cigarette arm, and seventy in the control. All groups had access to behavioral therapy. There was not a significant difference in achieving abstinence from combustible cigarettes between the nicotine and non-nicotine arm. 13 and 11 participants were tested to be eCO free after 6 months, respectively. However, both the

e-cigarette arms fared significantly better than the control arm. No benefits to pulmonary health were found in the study in any group.

Comparison of nicotine e-cigarettes in aiding smoking cessation and other nicotine delivery methods are the subject of most studies in this area of research. Often, though, studies will have an arm that only receives behavioral support or none at all. In a review of four of these studies, Hartmann-Boyce [1] among 955 participants, less than 1% were able to achieve smoking cessation. Combining these studies led to a risk-ratio of 2.50 for using e-cigarettes and obtaining smoking cessation over behavioral or no therapy. One of these studies, Halpern 2018 also examined whether financial incentives to quit smoking were superior to the use of nicotine e-cigarettes or NRT such as nicotine gum and patches. This is the last comparison that will be addressed in this review. There is only one study, albeit with a large sample size, which has been done.

6006 employees of 54 companies were divided into one of five arms in this study. One arm, as mentioned previously, consisted of simple behavioral support, which in this case consisted of a pamphlet with help on quitting smoking and motivational text messages. The subjects in the nicotine e-cigarette arm were not required to receive the pamphlets and messages, but were able to utilize them if desired. Subjects in a “cessation aid” arm were provided with free NRT or pharmacological interventions, and if those failed, they were given e-cigarettes as well. A fourth arm consisted of people who were given free cessation aids in addition to rewards valuing \$600 if they were able to maintain abstinence. Members of the last arm were given free cessation aid in addition to \$600 USD. The money was deposited in an alternate bank account and partially removed with each failure to achieve abstinence.

A participant was to receive \$100 for reaching one month of abstinence, and \$300 for reaching three months. At the end of the study, if smoking cessation had been maintained for the full six months, the participant would receive the full \$600. The study did not find e-cigarettes to be superior to the behavioural support consisting of pamphlets and the text messages, with a p value of only .20. Out of 1199 participants receiving e-cigarettes, four achieved abstinence. Unsurprisingly, however, financial incentives, both the rewards and the direct monetary deposits were effective. The deposits in particular were found to be more effective than e-cigarettes, the measured p value was .008. 35 out of the 1208 participants in the monetary reward arm-maintained abstinence. The study concluded with statistical significance that monetary rewards were more effective than just free cessation aids, and that neither e-cigarettes, nor standard behavioural support were effective.

Discussion

There were five methods of comparison employed in this review. Comparing the efficacy of nicotine e-cigarettes to nicotine

replacement therapies such as patches and gums was the first. This was followed by comparing nicotine e-cigarettes to varenicline. Also, the potential to reduce toxic metabolites in the body through e-cigarette usage was briefly mentioned. Then nicotine and non-nicotine e-cigarettes were compared. And finally, nicotine e-cigarettes were compared to receiving either behavioral or no support, and monetary rewards. Nicotine e-cigarettes were shown to be more effective at smoking cessation than NRT, resulting in four extra study participants quitting per one hundred Hartmann-Boyce [1]. This is shown in table format following this discussion, as, in this review, it is the most clinically relevant take-away supporting the efficacy of e-cigarettes.

NRT are a mainstay on drugstore shelves, they have been believed to be the therapy of choice for quitting smoking for decades. The gathered data has now shown that they are not superior in efficacy to nicotine e-cigarettes Hartmann-Boyce [1]. Varenicline might be the superior treatment for patients with a strong motivation to quit cigarettes. It was measured to have the highest correlation with inducing abstinence of any treatment, including e-cigarettes in patients having suffered from acute coronary syndromes. Toxic metabolite reduction is of potential interest for those studying the role of e-cigarettes for smoking cessation.

Currently, reduced levels of carbon monoxide among e-cigarette smokers compared to smokers of combustible cigarettes is statistically significant. Nicotine e-cigarettes are found to be more effective for quitting than non-nicotine e-cigarettes in most studies, again with statistical significance. Behavioral therapy and no therapy are clearly less effective than nicotine e-cigarettes, by a factor of 2.5. Monetary incentives, like varenicline pharmacotherapy, show statistical significance as a treatment more effective for smoking cessation than nicotine e-cigarettes. Though the success rate of quitting smoking is low, attempts have been rising Johnson [15] and new modalities and approaches have the potential to be useful for many who are motivated to quit. Therefore, it is of interest to the medical community anytime a new adjunct or standalone therapy is available for patients. For further updates, one can check the Hartmann-Boyce live literature review, which is updated monthly Hartmann-Boyce [1], and provides an on-going, serious analysis of all new research. With the newest generations of e-cigarettes still not extensively clinically studied, e-cigarettes may continue to develop into a stand-alone, effective treatment with the potential to lead to greater rates of smoking cessation [16-30].

References

1. Hartmann-Boyce J, McRobbie H, Lindson N, Bullen C, Begh R, et al. (2020) Electronic cigarettes for smoking cessation. *Cochrane Database Syst Rev* 10: CD010216.
2. Vallone DM, Cuccia AF, Briggs J, Xiao H, Schillo BA, et al. (2020) Electronic Cigarette and JUUL Use Among Adolescents and Young Adults. *JAMA Pediatr* 174(3): 277-286.

3. Patel M, Cuccia AF, Zhou Y, Kierstead EC, Briggs J, et al. (2020) Smoking cessation among US adults: Use of e-cigarettes, INCLUDING JUUL, and Nrt use. *Tobacco Control*.
4. Pierce JP, Benmarhnia T, Chen R, White M, Abrams DB, et al. (2020) Role of e-cigarettes and pharmacotherapy during attempts to quit cigarette smoking: The PATH Study 2013-16. *PLOS ONE* 15(9): e0237938.
5. Ioakeimidis N, Vlachopoulos C, Georgakopoulos C, Abdelrasoul M, Skliros N, et al. (2018) Smoking cessation rates with varenicline and electronic cigarettes in relapsed smokers with a history of acute coronary syndrome. *European Heart Journal* 39(Suppl_1): 242.
6. Jay J, Pfaunmiller EL, Huang NJ, Cohen G, Graff DW (2020) Five-Day Changes in Biomarkers of Exposure Among Adult Smokers After Completely Switching from Combustible Cigarettes to a Nicotine-Salt Pod System. *Nicotine Tob Res* 22(8): 1285-1293.
7. Pulvers K, Emami AS, Nollen NL, Romero DR, Strong DR, et al. (2018) Tobacco consumption and toxicant exposure of cigarette smokers using electronic cigarettes. *Nicotine & Tobacco Research* 20(2): 206-214.
8. Halpern SD, Harhay M O, Saulsgiver K, Brophy C, Troxel AB, et al. (2018) A Pragmatic Trial of E-Cigarettes, Incentives, and Drugs for Smoking Cessation. *New England Journal of Medicine* 378(24): 2302-2310.
9. Compton P, Campagna D, Cibella F, Morjaria JB, Caruso M, et al. Efficacy and Safety of an eElectronic cigAreTte (ECLAT) as tobacco cigarettes substitute: a prospective 12-month randomized control design study.
10. Fadus MC, Smith TT, Squeglia LM (2019) The rise of e-cigarettes, pod mod devices, and JUUL among youth: Factors influencing use, health implications, and downstream effects. *Drug Alcohol Depend* 201: 85-93.
11. Bullen C, Howe C, Laugesen M, McRobbie H, Parag V, et al. (2013) Electronic cigarettes for smoking cessation: a randomised controlled trial. *Lancet* 382(9905): 1629-1637.
12. Hajek P, Phillips-Waller A, Przulj D, Pesola F, Smith KM, et al. (2019) A Randomized Trial of E-Cigarettes versus Nicotine-Replacement Therapy. *New England Journal of Medicine* 380(7): 629-637.
13. Lee SM, Tenney R, Wallace AW, Arjomandi M (2018) E-cigarettes versus nicotine patches for perioperative smoking cessation: a pilot randomized trial. *Peer J* 6.
14. Hatsukami D, Meier E, Lindgren BR, Anderson A, Reisinger S, et al. (2020) A randomized clinical trial examining the effects of instructions for electronic cigarette use on smoking-related behaviors and biomarkers of exposure. *Nicotine Tobacco Research* 22(9): 1524-32.
15. Linda Johnson BS, Yinjiao Ma, Sherri L Fisher MS, Alex T Ramsey, Li-Shiun Chen, et al. (2019) E-cigarette Usage Is Associated with Increased Past-12-Month Quit Attempts and Successful Smoking Cessation in Two US Population-Based Surveys. *Nicotine & Tobacco Research* 21(10): 1331-1338.
16. Benowitz, NL (2019) E-cigarettes and dual nicotine replacement therapy for smoking cessation. *The Lancet Respiratory Medicine*.
17. Brown J, Beard E, Kotz D, Michie S, West R (2014) Real-world effectiveness of e-cigarettes when used to aid smoking cessation: a cross-sectional population study. *Addiction* 109(9): 1531-1540.
18. Cadet M (2019) Are E-cigarettes more effective in supporting smoking cessation than nicotine-replacement therapy? *Evidence Based Nursing*.
19. E-Cigarettes versus Nicotine-Replacement Therapy for Smoking Cessation (2019) *New England Journal of Medicine* 380(20): 1973-1975.
20. Erly BK, Prochazka AV (2019) E-cigarettes were more effective than nicotine replacement for smoking cessation at 1 year. *Annals of Internal Medicine* 170(10).
21. Frank AS, Sando K, McBane S (2018) Do Electronic Cigarettes Have a Role in Tobacco Cessation? *Pharmacotherapy* 38: 555-568.
22. Ghosh S, Drummond MB (2017) Electronic cigarettes as smoking cessation tool: are we there? *Curr Opin Pulm Med* 23(2): 111-116.
23. Goldenson NI, Leventhal AM, Stone MD, McConnell RS, Barrington-Trims JL (2017) Associations of Electronic Cigarette Nicotine Concentration with Subsequent Cigarette Smoking and Vaping Levels in Adolescents. *JAMA Pediatrics* 171(12): 1192-1199.
24. Goniewicz (2017). The QuitNic Study: a pilot study of electronic nicotine devices for smoking cessation with drug and alcohol clients.
25. Li J, Hajek P, Pesola F, Wu Q, Phillips-Waller A, et al. (2019) Cost-effectiveness of e-cigarettes compared with nicotine replacement therapy in stop smoking services in England (TEC study): a randomised controlled trial. *Addiction*.
26. Lucchiari C, Masiero M, Veronesi G, Maisonneuve P, Spina S, et al. (2016) Benefits of e-cigarettes among heavy smokers undergoing a lung cancer screening program: randomized controlled trial protocol. *JMIR Research Protocols* 5(1): e21.
27. Malas M, van der Tempel J, Schwartz R, Minchiello A, Lightfoot C, et al. (2016) Electronic Cigarettes for Smoking Cessation: A Systematic Review. *Nicotine Tob Res* 18(10): 1926-1936.
28. Rahman MA, Hann N, Wilson A, Mnatzaganian G, Worrall-Carter R (2015) E-cigarettes and smoking cessation: evidence from a systematic review and meta-analysis. *PLoS One* 10(3).
29. Cravo AS, Bush J, Sharma G, Savioz R, Martin C, et al. (2016) A randomised, parallel group study to evaluate the safety profile of an electronic vapour product over 12 weeks. *Regulatory Toxicology and Pharmacology* 81: S1- S14.
30. Zborovskaya Y (2017) E-Cigarettes and Smoking Cessation: A Primer for Oncology Clinicians. *Clin J Oncol Nurs* 21(1): 54-63.



This work is licensed under Creative Commons Attribution 4.0 License
DOI: [10.19080/ADOH.2023.16.555938](https://doi.org/10.19080/ADOH.2023.16.555938)

**Your next submission with Juniper Publishers
will reach you the below assets**

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats
(Pdf, E-pub, Full Text, Audio)
- Unceasing customer service

Track the below URL for one-step submission
<https://juniperpublishers.com/online-submission.php>