Self-Titration by Experienced E-Cigarette Users: Blood Nicotine Delivery and Subjective Effects

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Introduction

A number of studies on low nicotine tobacco cigarettes suggest that, through behavioural mechanisms, smokers alter their puffing in response to a change in nicotine concentration[1,2,3]. Nicotine titration is well documented in the tobacco literature. However, the extent to which e-cigarettes users (vapers) self-titrate is unknown. The newly implemented European Tobacco Product Directive (EU-TPD; 20th May 2016) by imposing restrictions on sales of nicotine concentrations above 20mg/mL, may compel vapers to reduce their nicotine intake and consequently lead to more intensive puffing behaviour to compensate for the sudden decrease in nicotine concentration.

Aims

To explore the effects of high and low nicotine concentration on puffing topography, nicotine delivery and subjective effects in experienced vapers.

Methods

- **Design**: Double-blind (order counterbalanced).
- **Participants**: Eleven experienced vapers (N = 11; all males) abstained from all nicotine use for 12h.
- **Materials and Measures**:
  - A ‘Joyetech’ eVic Supreme™ e-cigarette with an ‘Aspire’ tank recorded puff number and duration.
  - Exhaled Carbon Monoxide levels (CO).
  - Craving and withdrawal symptoms[4]
  - Nicotine dependence[5,6]
- **Procedure**: Participants completed 60 min of ad libitum vaping in 2 separate sessions (figure 1).

**Figure 1. Study protocol**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Baseline (12h abstinence)</th>
<th>10 min</th>
<th>30 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Blood samples</td>
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<tr>
<td>• Craving</td>
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<td>• Withdrawal symptoms</td>
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<td>• Withdrawal symptoms</td>
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</tr>
</tbody>
</table>

**Table 1. Puffing topography**

<table>
<thead>
<tr>
<th>Nicotine concentration (mg/mL)</th>
<th>Puff number</th>
<th>Puff duration (s)</th>
<th>Volume consumption (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low 6</td>
<td>48.36 (22.86)</td>
<td>3.84 (1.02)</td>
<td>0.64 (0.19)</td>
</tr>
<tr>
<td>High 24</td>
<td>70.73 (34.45)</td>
<td>5.20 (1.39)</td>
<td>1.23 (0.59)</td>
</tr>
</tbody>
</table>

**Figure 2. Mean Puff Number**

**Figure 3. Mean Puff Duration**

**Figure 4. Mean Volume consumed (mL)**

**Figure 5. Mean plasma nicotine boost**

**Discussion / Summary**

By using a pragmatic protocol which allowed participants to vape ad lib, this study is the first to provide direct empirical evidence of nicotine titration by vapers. Whilst compensatory puffing was sufficient to reduce craving and withdrawal discomfort, self-titration was incomplete with significantly higher plasma nicotine levels in the high condition. Such high plasma nicotine levels, typical in experienced vapers, may be partly attributed to the fast evolution of e-cigarette devices, and by providing such effective nicotine delivery may increase their appeal to highly dependent smokers attempting to quit.

**Implications**

Although many vapers gradually reduce their nicotine concentration overtime, most need to maintain it to remain abstinent. This study suggests that experienced vapers can partially compensate and achieve subjective satisfaction, nonetheless, this is at the expense of consuming a greater quantity of liquid. Further work may focus on the possible health and cost impacts of more intensive puffing patterns on users.