Nicotine Delivery and E-Cigarette Puffing Behaviour

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Declarations

- Conducted research for e-cigarette companies (2010-2013)
- Consultant for pharmaceutical industry (2014)
- Expert witness in e-cigarette patent infringement case (2014)
- No funding from tobacco industry
Self-Titration Hypothesis

Smokers adjust their nicotine intake to maintain a personal optimal level.

<table>
<thead>
<tr>
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<th>% difference from usual brand</th>
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<td></td>
<td>In cigs</td>
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<tr>
<td>High nicotine cig</td>
<td>30-40%</td>
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<tr>
<td>Low nicotine cig</td>
<td>50%</td>
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Smokers compensated for about 2/3 of the difference in nicotine yields (Ashton et al., 1979, BMJ)
Compensatory Puffing

- Usual brand
- Low Yield (38%)
- Switch at Trial 3

Hammond et al. (2005) *Cancer Epidemiol Biomarkers Prev*
• Smokers can achieve approx. 60-80% of the nicotine yield via compensatory puffing behaviour (Scherer & Lee, 2014)

• Mainly via taking longer, harder drags and more frequent puffs

• Switching to ‘light’ or reduced nicotine containing cigs doesn’t appear to reduce toxicant exposure and may even increase it.
E-cigarette nicotine delivery

14 experienced users took 10 puffs followed by 60min *ad lib* vaping

Dawkins & Corcoran (2014)
TPD Article 20

• Limit on nicotine concentrations > 20mg/mL
• 9% use above 20mg/mL (ASH, 2016)
• 1/5\textsuperscript{th} of e-cig users \textit{initiated} vaping with >20mg/mL nicotine concentration (Farsalinos et al., 2013)
Aims

To explore:

1. the extent to which e-cigarette users self-titrate when given a lower nicotine concentration liquid

2. subjective effects (craving, withdrawal symptoms, positive and negative effects) and plasma nicotine concentrations between conditions (high vs. low nicotine concentration liquid)
Methods

- **Participants**: 11 male experienced e-cig users
- **E-cigarette**: eVic Supreme (Joyetech) with Aspire tank (Nautilus)
- **E-liquid**: 6 & 24mg/mL tobacco flavour (Halo Smokers’ Angels)
- **Double-blind, counterbalanced**
Measures

• Puffing topography: puff number, puff duration, mL consumed

• Mood & Physical Symptoms & Urge to Vape (West & Hajek, 2004)

• Positive Effects (e.g. hit, satisfaction on VAS)

• Negative Effects (e.g. nausea, dry mouth on VAS)
Procedure

- Pre-study Screening
- Overnight abstinence
- baseline
- 10 mins
- 30 mins
- 60 mins

Salivary cotinine > 100ng/mL

Blood Craving Withdrawal symptoms

Blood Craving Withdrawal symptoms
Puffing topography

Blood Craving Withdrawal symptoms
Puffing topography
Positive & negative effects

Ad lib vaping

Repeated under high and low nicotine concentration conditions
Puffing topography

More puffs, longer puffs and more liquid consumed in the low (6mg/mL condition (p < 0.05)
Blood nicotine delivery

Incomplete self-titration from compensatory puffing
Blood nicotine/puffing topography correlations

High: $r = 0.85^{**}$; Low: $r = 0.75^{**}$

High: $r = 0.56^{*}$; Low: $r = 0.22$

** $p < 0.01$; * $p < 0.05$
Subjective effects

No significant differences between conditions in urge to vape or withdrawal symptoms.
Positive Effects

Trend for higher ratings of hit and satisfaction in the high nicotine condition (p = 0.11 & p = 0.09)
Conclusions

• Clear evidence of compensatory puffing with lower nicotine concentration e-liquid
• Self-titration was partially effective…
• … equivalent reduction in urge to vape and withdrawal symptoms across conditions…
• …but significantly higher levels of blood nicotine in the high condition
• Very high levels of nicotine can be achieved very quickly (equivalent to smoking) under certain conditions
Question

More vaping with less nicotine or less vaping with more nicotine?

Does it matter?
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