Comparison between particulate matter mass, number of particles, ultrafine particle and black carbon emissions by electronic and normal cigarettes in real-life conditions

Ario Alberto Ruprecht1,*, Cinzia De Marco1, Paolo Pozzi1, Elena Murarini2, Roberto Mazzia3,*, Giorgia Angelotti4, Francesca Turfa1, Roberto Boffi5

1 Tobacco Control Unit, Fondazione IRCCS Istituto Nazionale dei Tumori, Milan; 2 LARS, Environmental Research Laboratory, SIMG, Società Italiana di Medicina Generale, Italian College GPs, Florence, Italy; 3 Patient Information Service, Fondazione IRCCS Istituto Nazionale dei Tumori, Milan, Italy. Ario Alberto Ruprecht and Cinzia De Marco contributed equally to this work.

Mailing address: aaruprecht@gmail.com; Phone: +39-3485862441; E-mail: cinzia.demarco@istitutotumori.mi.it

Alma: An electronic cigarette is a battery-powered device that produces an aerosol containing a mixture of nicotine, propylene glycol and flavoring, depending on the different commercial brands. E-cigarettes pose a regulatory challenge to the medical community, as they may reduce the harm of cigarette smoke but at the same time reinforce addictive smoking behavior. Uncertainties also exist as to whether they do promote a clinically relevant cessation rate in smokers who use e-cigarettes to quit smoking. Furthermore, e-cigarettes are supposed to emit much fewer pollutants in both particulate matter (PM), fine particles (FP), ultrafine particles (UFP) and black carbon (BC). The aim of the present study was to investigate the emission of PM generated by e-cigarettes and normal cigarettes under real-life conditions.

Methods: Real-time measurement and comparison of electronic cigarettes (Elips Series C, with and without nicotine 16 mg, Ovale Europe Srl) with and without nicotine and normal cigarettes in a 48 m² normal office of an Italian comprehensive cancer institute with no air conditioning and 0.8 air exchange rate (ACH) of PM mass using pre-calibrated model Aerocel 531 of Metone Instruments Inc. as PM1, PM2.5, PM10, and TSP in μg/m³. FP number of particles on 8 sizes from 0.3 to 10.0 μm using model 212-2 of Metone Instruments Inc., UFP in number of particles per cubic centimeter from 10 to 1,000 nanometers using model TSI3007 of TSI and BC using model AE31 of Mage Scientific Inc. Vapor phase nicotine was measured using passive filters and GC analysis. Outdoor concentrations were measured contemporaneously to compensate for urban background changes and all data are expressed in difference over the background.

Results:

Negative numbers in red. Measurements of very small negative values in concentrations may be due to the instrument intrinsic noise level. Test t of Student e-cig without nic with normal cig p = < 0.0001

Emission factor in μg/min of e-cig not applicable. For normal cigarettes results as table below:

<table>
<thead>
<tr>
<th>PM1</th>
<th>PM2.5</th>
<th>PM10</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.21</td>
</tr>
</tbody>
</table>

- Test of Student e-cig without nic with normal cig p = < 0.0001
- Test of Student e-cig with and without nic p = < 0.0001

Conclusion: Our investigation proved that e-cigarettes produce much less PM than conventional cigarettes and no black carbon and therefore may be less hazardous for smokers and also in terms of secondhand exposure. This finding can be of interest to physicians and policy makers, but further studies are necessary to investigate acute and chronic effects of secondhand exposure to e-cigarette smoke in order to rule out any possible issues of health concern.

NICOTINE THREE TESTS: e-cigs below detection limit of 0.02 μg/m. Normal cigarettes showed concentrations of: 16.54, 26.04 and 16.41 μg/m³.