



Working for a tobacco-free Scotland

## ASH Scotland Third-hand smoke June 2011

### Key points:

- the 'three r' definition of third-hand smoke is that it describes residual tobacco smoke pollutants which **remain** on surfaces and in dust after tobacco has been smoked, are **re-emitted** back into the gas phase, or **react** with oxidants and other compounds in the environment to yield secondary pollutants
- even without understanding what third-hand smoke is, people have long been aware of its presence and are beginning to understand how it can affect clothes, hair, cars and homes, and create stains and odours
- existing evidence on THS suggests a strong need for further research to close gaps in the current understanding of the chemistry, exposure, toxicology, and health effects, as well as behavioural, economic, and socio-cultural consequences<sup>1</sup>
- whereas there is a long-established evidence base for the health impact of second-hand smoke, there is still a lack of human health studies on the potential health impact of third-hand smoke
- the greater and more quantifiable health dangers from SHS suggest that health professionals should focus on reducing exposure to SHS, including by promoting smoke-free homes and vehicles.

**This briefing is for parents and carers who smoke and those who work with them. It aims to explain what third-hand smoke is, how it relates to second-hand smoke, and what is currently known about the mechanisms by which it could affect health.**

### Tobacco smoke pollution:

- **first-hand smoke** is smoke which is inhaled into a smoker's own lungs, and is also called active smoking or mainstream smoke
- **second-hand smoke (SHS)** is the product of mainstream exhaled smoke and side-stream smoke from the smouldering tip of a cigarette
- **third-hand smoke (THS)** 'consists of tobacco smoke pollutants that **remain** on surfaces and in dust after tobacco has been smoked, are **re-emitted** and re-suspended back into the air, or **react** with oxidants and other compounds in the environment to yield secondary pollutants'<sup>2</sup>. When a cigarette is extinguished and second-hand smoke has dispersed, third-hand smoke may form a residue and build up in enclosed spaces where there is also nitrous acid\* (which may form in rooms with poorly-

\* **Nitrous acid** is produced in engine exhaust emissions but is also a common indoor pollutant produced by poorly vented domestic gas appliances.

vented gas appliances) and/or ozone<sup>†3</sup> in the atmosphere. It is the resulting residue which adheres to indoor surfaces and can persist for months which some researchers believe poses a health hazard to infants.

## Why might third-hand smoke be a health hazard?

A 2010 study<sup>4</sup> indicated that third-hand smoke accumulates in smokers' homes and persists even after homes have been vacant for two months and are cleaned and prepared for new residents; the study suggested that non-smokers living in former smoker homes are exposed to THS in dust and on surfaces. Nicotine sticks to surfaces rapidly, comes off very slowly and increasing ventilation in a home will not remove the residue stuck to surfaces and dust<sup>5</sup>. A researcher from one study into third-hand smoke<sup>6</sup> noted in interview<sup>7</sup> that as soap is alkaline it will not remove nicotine residue, and that removing third-hand smoke in the form of nicotine residue from carpets which have had long-term exposure, would be nearly impossible.

Infants inhale double the quantity of household dust compared to adults, and so inhale more dust containing second-hand smoke particulates (perhaps 40 more times more per body weight than adults)<sup>8</sup>. Infants also have greater hand/object/mouth contact, and so absorb proportionately more through ingestion, as well as through inhalation<sup>9</sup>. There has been research that suggests that third-hand smoke is potentially hazardous to the health of foetuses<sup>10</sup>, babies and small children, however there is as yet no direct evidence examining health outcomes in children or adults as a result of THS exposure. When reacting with nitrous acid or ozone third-hand smoke can contain tobacco-specific nitrosamines (TSNs)<sup>‡</sup> some of which are known human carcinogens and one study<sup>11</sup> suggested that, given the rapid absorption and persistence of high levels of nicotine on indoor surfaces there was 'an unappreciated health hazard through dermal exposure, dust inhalation, and ingestion'. Once again it is important to note that although the ultrafine particles are capable of depositing on surfaces and later re-suspending into the air, the airborne concentrations are 100 times lower than levels in second-hand smoke<sup>12</sup>.

In summary, whilst there is evidence of a mechanism by which potentially harmful TSNs may be released into the environment, there is limited evidence of the extent to which this occurs in real-life situations, and no studies directly

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<sup>†</sup> **Low level ozone** is an atmospheric pollutant formed by the reaction of sunlight on air containing hydrocarbons and nitrogen oxides that react to form ozone directly at the source of the pollution or many kilometres down wind. It can infiltrate enclosed spaces.

<sup>‡</sup> **Tobacco specific nitrosamines (TSNs):** the two main TSNs in third-hand smoke are 1-(*N*-methyl-*N*-nitrosamino)-1-(3-pyridinyl)-4-butanal (NNA) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK). Nitrosamines can damage DNA and NNK is a known human carcinogen. IARC. Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 89 (2007). Smokeless Tobacco and Some Tobacco-specific N-Nitrosamines. Lyon, France:International Agency for Research on Cancer (2007). Available: <http://monographs.iarc.fr/ENG/Monographs/vol89/mono89.pdf> [Accessed 11.05.11]

measuring the impact on health of THS exposure independently of exposure to SHS.

## **Why is second-hand smoke a health hazard?**

Second-hand smoke (SHS or passive smoking) is smoke from other people's tobacco and breathing it in brings non-smokers many of the same health risks as active smoking<sup>13</sup>. Inhaling SHS can cause cancer in non-smokers and many of the cancer-causing chemicals are present in higher concentrations than in the smoke inhaled by the smoker themselves<sup>14</sup>. Just thirty minutes of exposure to second-hand smoke can cause heart damage similar to that of active smokers<sup>15 16</sup> as non-smokers' heart arteries show a reduced ability to dilate, diminishing the ability of the heart to get blood. In addition, the same half hour of second-hand smoke exposure activates blood platelets, which can initiate the process of atherosclerosis (blockage of the heart's arteries) that leads to heart attacks. These effects may explain other research showing that non-smokers regularly exposed to SHS suffer death or disease rates 30% higher than those of unexposed non-smokers<sup>17</sup>.

## **Health risks of active smoking**

In Scotland, 23% of all male deaths, 25% of all female deaths, 90% of lung cancer deaths in men aged over 35 years and 89% of lung cancer deaths in women aged over 35 can be directly attributed to tobacco use<sup>18</sup>. Twenty-two years of life are lost on average among men and women in middle age (35-69) from smoking<sup>19</sup>. Smoking is the most important modifiable lifestyle factor.

## **Conclusion**

Scientists have called for more research into third-hand smoke to assess risks to humans before it is pronounced dangerous<sup>20</sup>. In 2010 the United States Tobacco-Related Disease Research Program (TRDRP) announced a Request for Proposals to undertake studies on third-hand smoke and cigarette butt waste, and approximately \$3.75 million has been awarded<sup>21</sup>.

Research demonstrates that tobacco smoke is a toxic substance with no safe level of exposure, and that the risks from exposure are largely dose-related<sup>22</sup><sup>23</sup>. Active smoking carries overwhelming risks to health, cutting short the lives of one in two regular long-term smokers<sup>24</sup>. Supporting smokers to quit must remain a high priority for all concerned with public health. Risks from breathing second-hand tobacco smoke are also established<sup>25</sup> and quantified with particular risks during pregnancy<sup>26</sup>, to young children<sup>27</sup>, and to people with various medical conditions<sup>28 29</sup>. The damage from breathing tobacco smoke can occur even during brief periods of exposure<sup>30</sup>.

There is still limited evidence examining THS's effects on human health, and the studies conducted to date should be viewed in the context of the well-established risks of both active smoking and breathing second-hand tobacco smoke. These risks are likely to be significantly stronger, and broadly to operate in accordance with the dose-response principle.

In many cases, the results of studies on the health effects of second-hand smoke will already incorporate any negative impacts on health from exposure to THS, as they are frequently based on comparisons of individuals from smoking environments - where THS will be present - with those from non-smoking environments. Evidence of the impact of THS alone on human health is limited.

Based on what is currently known from research, both active smoking and inhaling second-hand smoke pose greater and more quantifiable risks than THS exposure. The focus for health professionals should remain on supporting individuals to quit smoking, and on working to reduce exposure to second-hand tobacco smoke, including by promoting smoke-free homes and vehicles.

### **Further information:**

Also see ASH Scotland information briefings - free to download as pdfs from: [www.ashscotland.org.uk/ash/4261](http://www.ashscotland.org.uk/ash/4261):

- [Child exposure to second-hand smoke in the home](#)
- [Second-hand smoke in cars](#)
- Second and third-hand smoke-related research articles identified each week from PubMed by the ASH Scotland Information Service: [www.ashscotland.org.uk/information/tobacco-related-research/research-2011/second-hand-and-third-hand-smoke](http://www.ashscotland.org.uk/information/tobacco-related-research/research-2011/second-hand-and-third-hand-smoke)



### **The REFRESH (Reducing families' exposure to second-hand smoke in the home) Project**

ASH Scotland, in partnership with the Universities of Aberdeen and Edinburgh is funded by the Big Lottery Fund research grants programme to manage an innovative three year research project that aims to reduce children's exposure to SHS in the home and is

designed to be delivered by community health workers.

The new intervention being tested compares changes in SHS concentrations in the home before and after mothers receive advice on reducing children's exposure. The intervention is designed to provide parents with scientifically measured feedback on the effect their smoking has on air quality within their home. It also provides parents with advice on how to minimise children's exposure to SHS and measures the extent to which they change their behaviour as a result. The particularly novel element is the use of air quality monitors to provide real scientific data to parents.

For more information visit: [www.ashscotland.org.uk/projects/refresh](http://www.ashscotland.org.uk/projects/refresh)

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