The human bitumen study hits the headlines

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Besides the current cutting-edge topics in toxicology, such as oxidative stress research (Baird and Dinkova-Kostova 2011; Barcelos et al. 2011; Cadenas et al. 2010), metal toxicity (Antonini et al. 2011; Bolt et al. 2011; Sinicropi et al. 2010), nanotoxicology (Weiss and Diabaté 2011), in vitro systems (Heise et al. 2012; Knobloch et al. 2012; Zellmer et al. 2010), and modelling (Mielke et al. 2011; Hoehme et al. 2010), bitumen research has led an essentially wallflower existence. Fortunately, this has dramatically changed since the recent publications from the Human Bitumen Study (Schlüter 2011; Raulf-Heimsoth et al. 2011a). Bitumen was already regarded as a suspected carcinogen in the 1980s (Schlüter 2011; Greim 2001). However, the discussion surrounding bitumen exposure as a potential health hazard was always controversial. On the one side, a long-term carcinogenicity study with dermal application yielded positive results (Sivak et al. 1997). Conversely, a long-term inhalation study—probably the more relevant route of application—did not lead to increased tumour incidence in rats (Fuhst et al. 2007). Furthermore, a small biomonitoring study did not show increased levels of DNA strand breaks in lymphocytes of bitumen workers (Fuchs et al. 1996). However, some evidence of increased DNA damage was found in roofers who

process bitumen at higher temperatures (Fuchs et al. 1996). Therefore, key questions are whether bitumen causes genotoxicity in exposed workers and whether inhalation is toxic to the airways. The recently published Human Bitumen Study is the largest worldwide and best-controlled study in this field, encompassing 500 exposed workers from 80 construction sites. The results, in a nutshell, show that DNA adducts and strand breaks in bitumen workers were within the range found in healthy individuals. On the other hand, bitumen workers showed chronic inflammation in the lower airways. The practical consequences for both industry and occupational medicine include the need to reduce the processing temperature of bitumen as much as possible, as temperature represents the most critical factor influencing bitumen vapour exposure. Finally, follow-up studies are needed to assess the relevance of the identified airway inflammation. In particular, the relevance of subtle changes of inflammatory mediators in the lower airways (e.g. interleukins) is of general importance in chemically induced airway inflammation and currently discussed in regulatory toxicology. To give our readers a rapid overview, we summarised the key findings of the Human Bitumen Study (Table 1).

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Table 1 Key messages of the cross-shift design study of bitumen-exposed workers

Key result	Reference
This article summarises the most important findings of the Human Bitumen Study which includes 500 workers from 80 construction sites. The results in a nutshell: Bitumen exposure did not cause genotoxicity but subchronic inflammation of the upper airways	Raulf-Heimsoth et al. (2011a)
Quantification of bitumen-derived matter in aerosols still remains a challenge and differences in sampling and analytical methods should be considered. PAH exposure for mastic asphalt workers was higher compared to construction sites without bitumen application. However, the exposure of coke-oven workers is at least one order of magnitude higher when compared to bitumen workers	Breuer et al. (2011)
Processing temperature of bitumen is critical for exposure. Therefore, reducing the processing temperature represents an efficient protective measure	Spickenheuer et al. (2011)
Urinary levels of PAHs are only of limited value when it comes to the biomonitoring of bitumen-exposed workers, because (1) the PAH content of bitumen is relatively low, (2) cigarette smoking has a strong influence, and (3) additives are increasingly used in asphalt mixtures	Pesch et al. (2011)
Bitumen-exposed workers showed potentially (sub) chronic irritative inflammatory effects in the lower airways	Raulf-Heimsoth et al. (2011b)
DNA adducts and strand breaks in bitumen workers were within the range found in healthy individuals, although slightly higher in exposed workers compared to non-exposed controls. Overall, it is unlikely that bitumen exposure at the workplaces causes DNA damage	Marczynski et al. (2011)
Bitumen exposure did not cause a relevant increase in micronucleus frequencies in peripheral blood lymphocytes of workers	Welge et al. (2011)
The influence of 18 SNPs on urinary PAH metabolites was relatively weak, with the GSTM1 deletion and NAT2- and CYP1A1-associated variants showing borderline significant effects	Rihs et al. (2011)
Mastic asphalt application led to significantly higher bitumen vapour exposure than rolled asphalt application	Raulf-Heimsoth et al. (2011c)

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