



Reducing occupational exposure of dermatology nurses to PAH

Determination of uptake after introduction of new personal skin protection

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Introduction

Percival Pott (1714-1788) was the first to demonstrate that a malignancy was linked to an environmental factor by discovering scrotum cancer in chimney sweeps



PERCIVAL POTT



Introduction

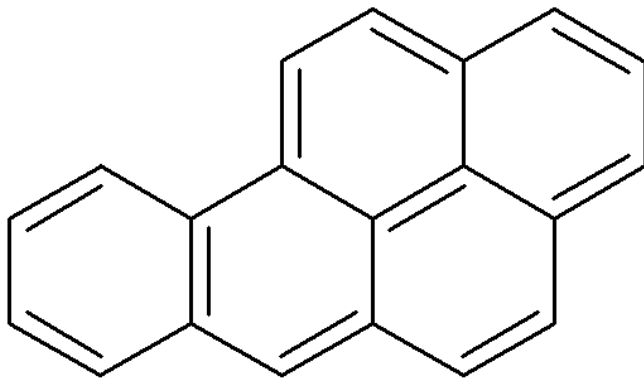
- Coal tar is one of the oldest dermatologic therapies, used especially for the treatment of psoriasis
- Coal tar ointments (CTO) contain polycyclic aromatic hydrocarbons (PAH)
- PAH are skin-absorbed
- PAH are carcinogenic



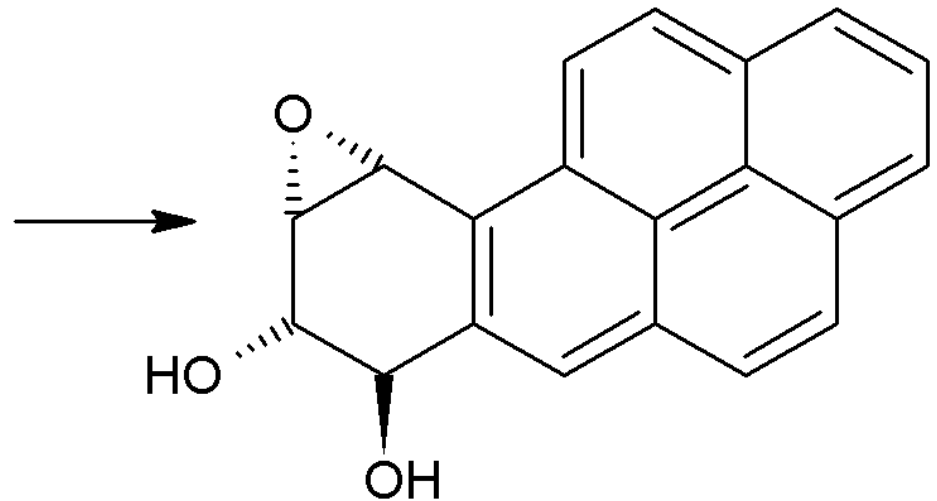


Introduction

PAH are bioactivated by CYP isoenzymes



benzo(a)pyrene
(BaP)



benzo(a)pyrene dihydrodiol epoxide
(BPDE)



Introduction

Sources of exposure to PAH:

Occupational exposures

Tobacco smoking/passive smoking

Fried/barbecued/smoked fish/meat

Creosote paint (carbolineum)

Tar shampoo

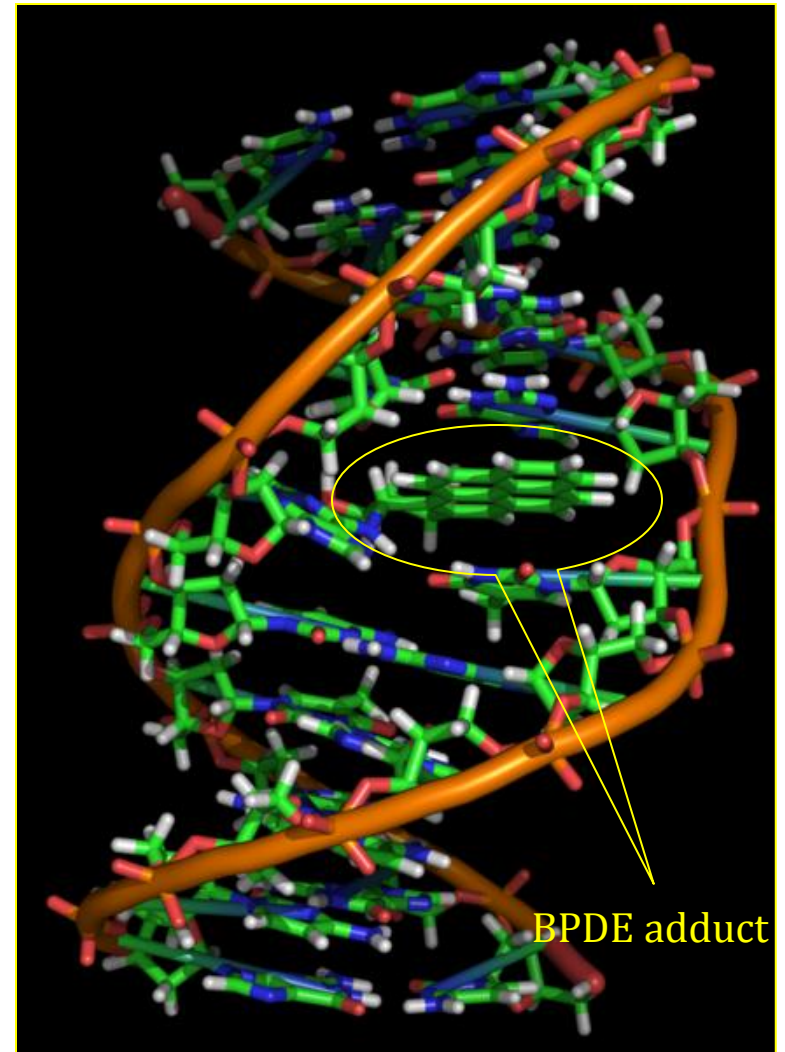
'Scotch' whisky

House dust (parquet floors)

Air pollution

Water pollution

Everyone is exposed to some extent





Introduction

- The tar is added to zinc oxide paste or white petrolatum.
- The coal tar is applied on the affected skin in thick layers.
- The treated skin is then covered with a tubular bandage.
- If needed sometimes the entire body surface is treated (such patients are admitted to the hospital)

	PAH content ($\mu\text{g/g}$ CTO)	
	Pyrene (PYR)	Benz[a]pyrene (BaP)
Dark	965	455
Light	3.0	0.13



Introduction

- Cohort study including 13,200 patients with psoriasis and eczema from The Netherlands and Belgium
- Median duration of follow-up 21 years
- Information on skin disease and treatment was retrieved from medical files: the median treatment duration was 6 months
- Patients treated with CTO were compared with patients treated with corticosteroids (no presumed cancer risk)
- No increase of risk of skin cancer HR = 1.09 [0.69-1.72]
- No increase of non-skin malignancies HR = 0.92 [0.78-1.09]



Introduction

The current practice:

- Treatment of each patient takes 10 – 30 minutes
- Gloves were used but not always when treating children



Fitting tubular bandage in young patients is often done without proper protection of the skin



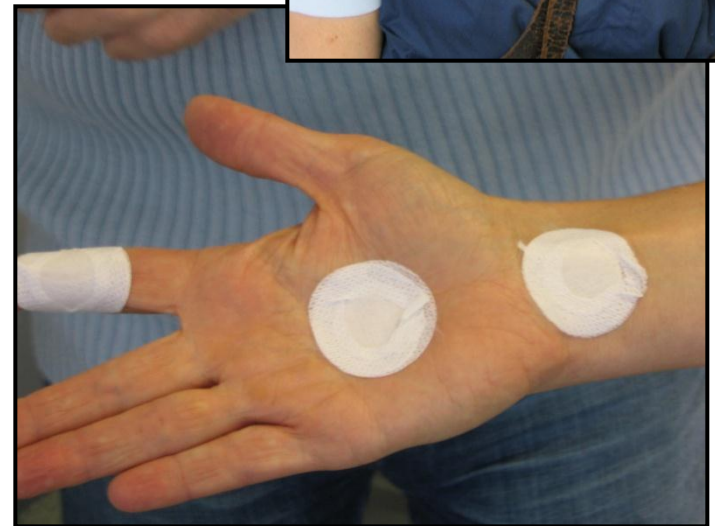
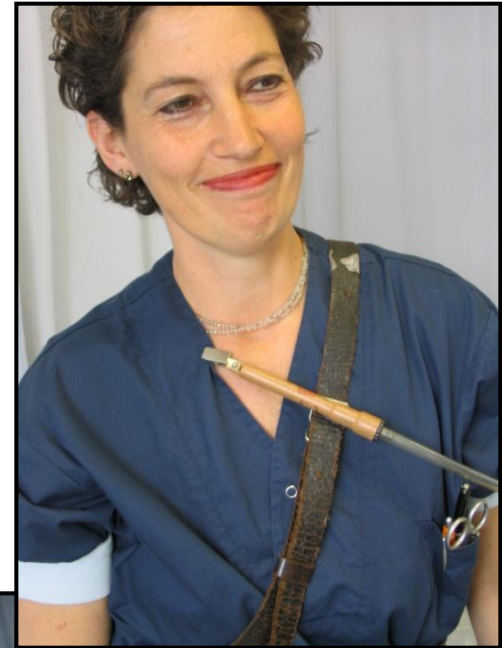
Aim

- Does the application of CTO lead to an increased uptake of PAH in nurses?
- What is the most important porte d'entrée?
- Does the use of gloves lead to a reduction in uptake?



Methods

- PYR and BaP were used as markers
- Gas phase PAH were determined using XAD-2
- Particulate PAH were determined on Teflon filters
- Contamination of the skin was determined using pads containing polypropylene membrane filters





Methods

- Uptake of PAH was assessed by determination of 1-hydroxypyrene (1-OHP) in spot urine samples
- One pre-shift sample was collected to determine baseline excretion
- Urine samples were collected until 10, 24 or 48 h after the start of the use of CTO
- The nurses registered the volume of each collected void.
- Using this procedure the total amount of 1-OHP excreted during 10, 24 or 48 h could be calculated.



Results

Group results (median and range) from 12 nurses in 2004 (48 h).
PAH were not detected in the air (PYR < 1.2 ng/m³; BaP < 0.02 ng/m³)

Skin contamination				Excretion of 1-OHP		
Finger (ng/cm ²)	Palm (ng/cm ²)	Wrist (ng/cm ²)	Total (ng)	Highest (μmol/mol crea)	Change from baseline (μmol/mol crea)	Total (nmol)
52 (9.4-189)	5.0 (0.2-202)	16 (0.2-300)	174 (1.1-338)	0.12 (0.04-0.35)	0.04 (-0.09—0.18)	2.5 (1.3-8.3)

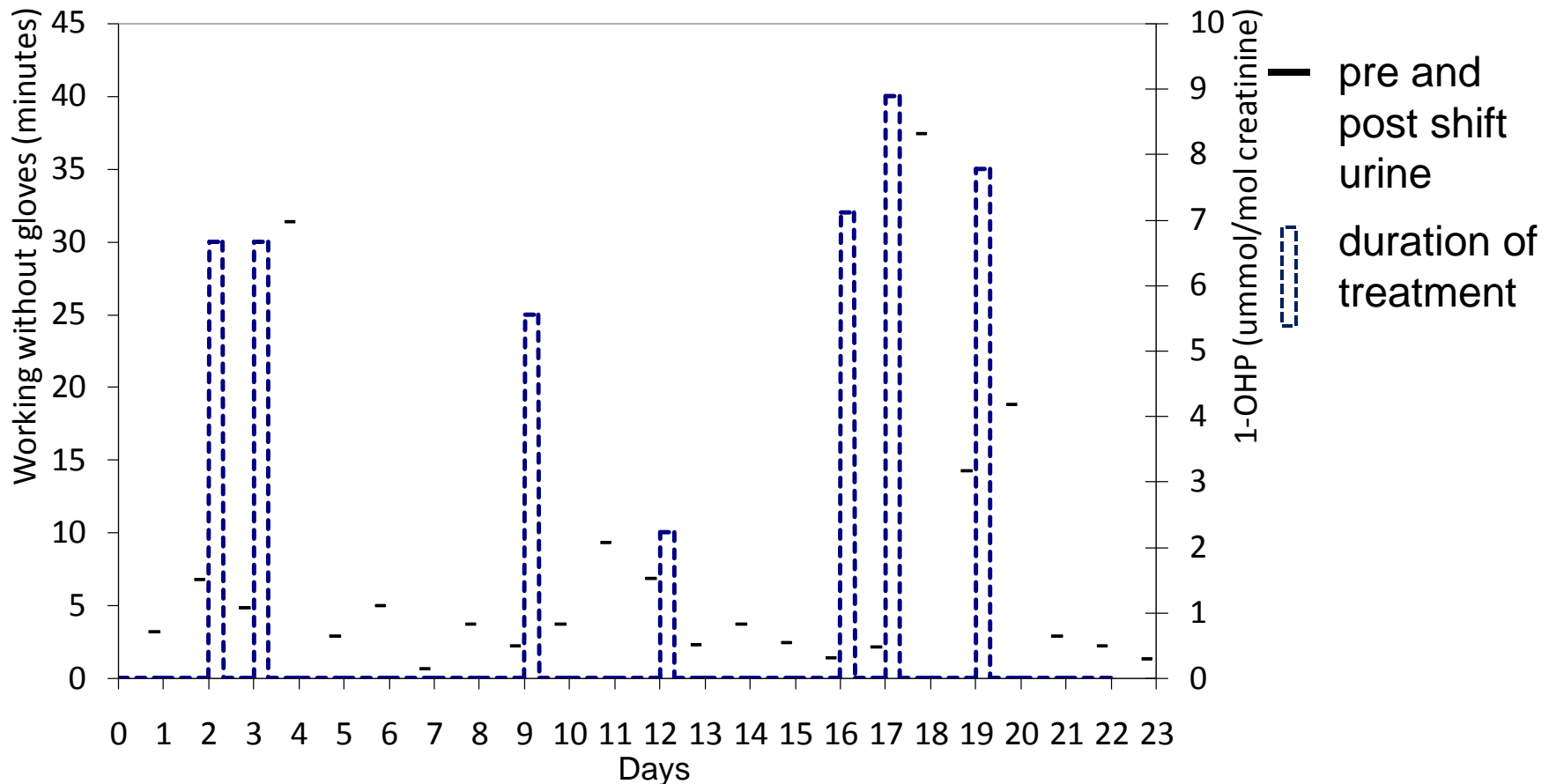
Amount of CTO applied
Duration of CTO treatment
Amount of PAH on skin

} no correlation with 1-OHP excretion



Results

Three weeks follow up in one nurse working a total of 422 h with CTO (including 202 h without gloves, as shown below)



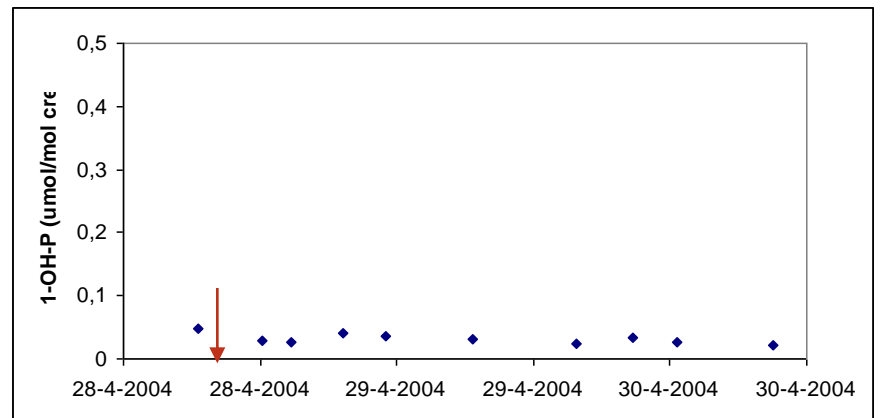
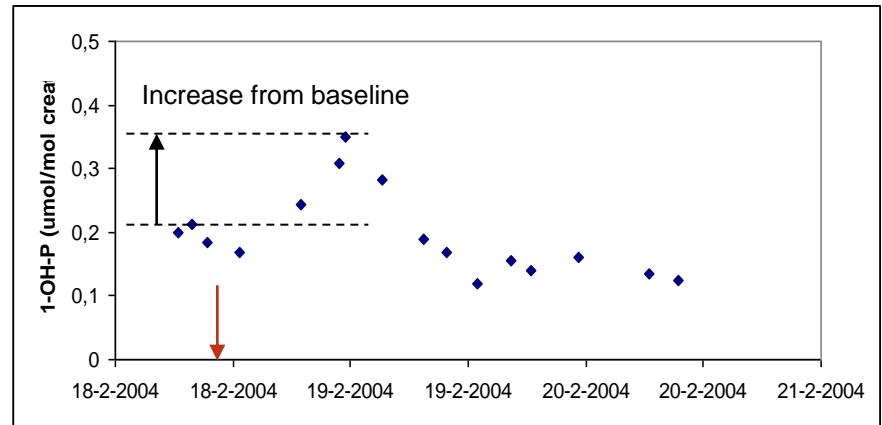


Results

Examples of follow-up of nurses who treated just one patient. The moment of treatment is indicated by ↓

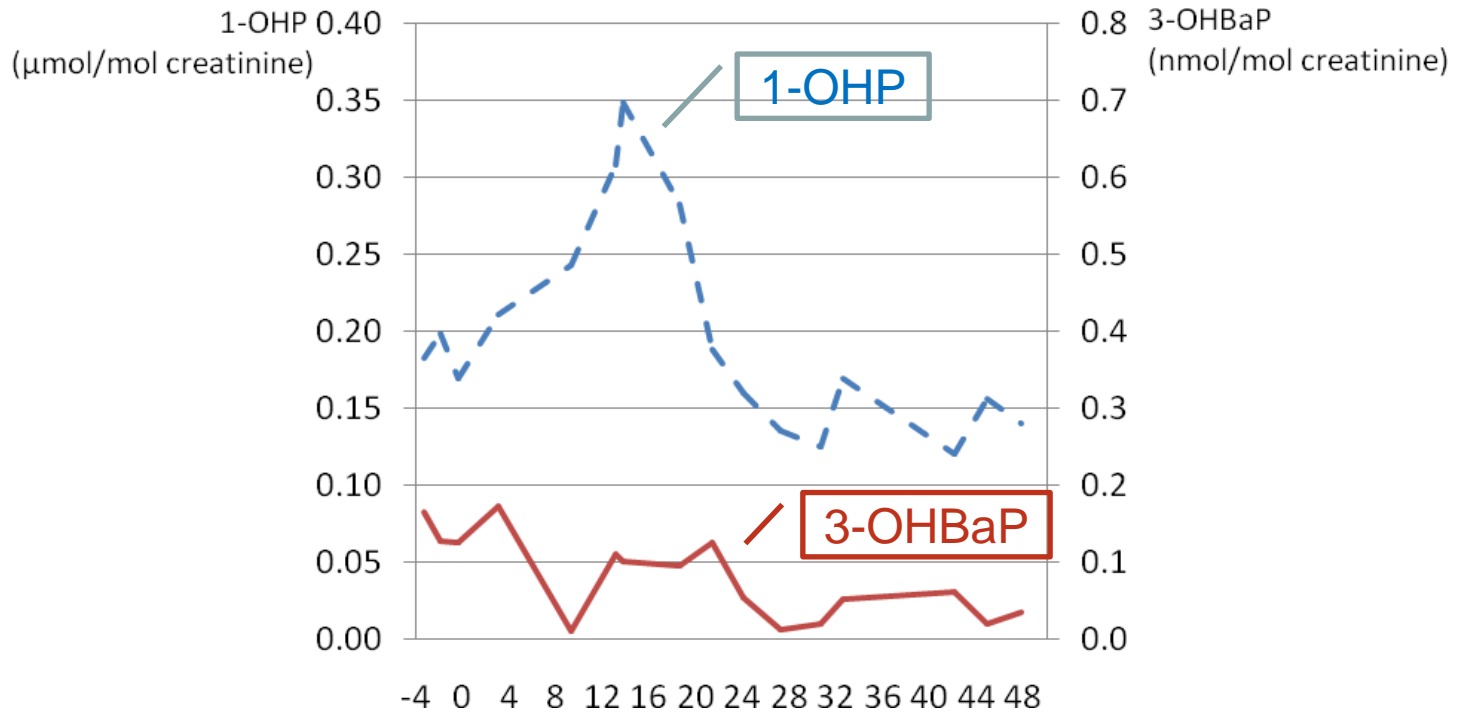


In nurses who reported visible contamination of hands the excretion of 1-OHP was (on average) two-fold increased





Results





Results

Nurses were asked to treat one patient with and one patient without gloves and collect urine samples over a period of 10 h.

N = 35	Total amount excreted (μmol) ^a	Highest post-exposure level ($\mu\text{mol}/\text{mol creat}$)	Baseline ($\mu\text{mol}/\text{mol creat}$)	Change from baseline ($\mu\text{mol}/\text{mol creat}$)
Without gloves	1.34 (0.19 – 5.6)	0.31 (0.06 – 0.98)	0.05 (0.01 – 0.28)	0.23 (0.00 – 0.74)
With gloves	0.69 *** (0.17 – 3.3)	0.12 (0.04 – 0.70)	0.04 (0.01 – 0.13)	0.06 (0.00 – 0.57)
Change	-0.58 (-1.0 – 5.1)	-0.18 (-0.81 – 0.04)	0.00 (-0.09 – 0.14)	-0.16 (-0.74 – 0.02)

*** $p < 0.001$; ^abased on samples collected between 8 and 18 h following the application



Results

It was suggested that the type and use of gloves could be improved.



2004: loose-fit PE gloves



2007: tight-fit vinyl gloves + Tyvek® sleeve



Results

Comparison of skin contamination on pads (ng)

Subgroup	Sub-stance	2004		2007	
		Median	Range	Median	Range
Paired observations (N = 6)	PYR	349	145.6-1113	0.9**	nd – 35.6
	BaP	184	60.5-394	4.6*	0.2-31.7
Unpaired observations (N = 10 -12)	PYR	173	1.1-1113	3.7*	nd-93.5
	BaP	107	5.5-394	3.2*	0.5-171

nd = not detected; * $p < 0.005$; ** $p < 0.001$



Results

Comparison of excretion of 1-OHP (total and increase from baseline)
Based on collection of urine during 24 h after application of CTO.

Subgroup	1-OHP	2004		2007	
		Median	Range	Median	Range
Paired observations (N = 6)	Total (nmol)	1.6	0.84-5.0	0.69*	0.45-3.4
	Increase ($\mu\text{mol/mol creat}$)	0.05	-0.01-0.18	0.03	0.01-0.17
Unpaired observations (N = 10 –12)	Total (nmol)	1.5	0.74-5.0	0.64*	0.15-2.8
	Increase ($\mu\text{mol/mol creat}$)	0.04	-0.09-0.18	0.02	-0.01-0.05

* $p < 0.05$



Discussion

- The skin contamination on pads was reduced dramatically (two orders of magnitude)
- This resulted in a $> 50\%$ reduction of uptake of PAH as indicated by excretion of 1-OHP



“Before”



“After”



Discussion

Dr. Frans Jongeneelen et al. proposed the following reference values:

- 0.76 $\mu\text{mol/mol}$ creatinine for smokers
- 0.24 $\mu\text{mol/mol}$ creatinine for non smokers

Not wearing gloves 17/35 nurses (49 %) would be classified as 'occupationally exposed'.

Wearing gloves reduced this number to 2/35 nurses (6 %).





Conclusions

- Everyone is exposed to PAH from life style factors and environmental sources
- (Dark) Coal tar ointments (like many other medical drugs) have a carcinogenic potency due to a relatively high content of PAH
- Biological monitoring is a useful tool to study low occupational exposures in a clinical setting
- Effectiveness of skin protection was demonstrated (> 50 % reduction)
- This reduction brings the exposure level down to beyond levels that are recognized/classified as 'occupational exposure'



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