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Firefighter Cancer in the New Fire Environment

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Workers Compensation



Learning Objectives

- Discuss the contribution of cancer and coronary heart disease to on duty and retirement death and disease in firefighters, including the personal and work related contributors to these risks.
- Awareness of possible health hazards of combustion products of synthetic materials to firefighters and families.
- Discuss why skin contamination may be a crucial issue in firefighters' cancer and risk of adverse reproductive outcome associated with their occupation.
- Awareness of additional factors relevant to firefighting that affect the absorption of chemicals deposited on the skin.

Research Requires Collaboration!



Cancers of Firefighters

Review of 32 articles on firefighters (110,000 full-time firefighters) and health effects found:

- Cancers probably elevated in firefighters are:
 - Multiple myeloma
 - Non-Hodgkins lymphoma
 - Prostate cancer
 - Testicular cancer

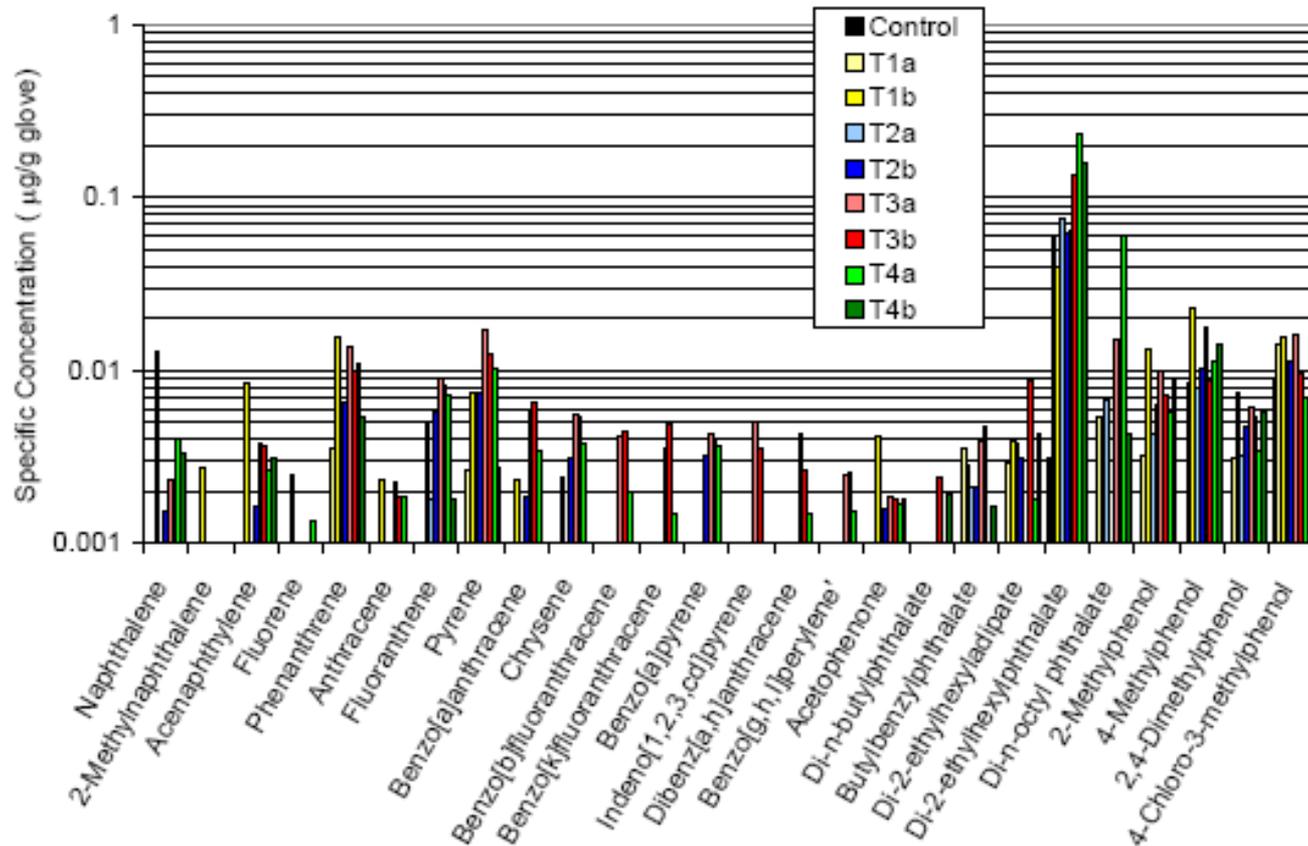
LeMasters GK et al, 2006. Cancer risk among firefighters: A review and meta analysis of 32 studies. JOEM.



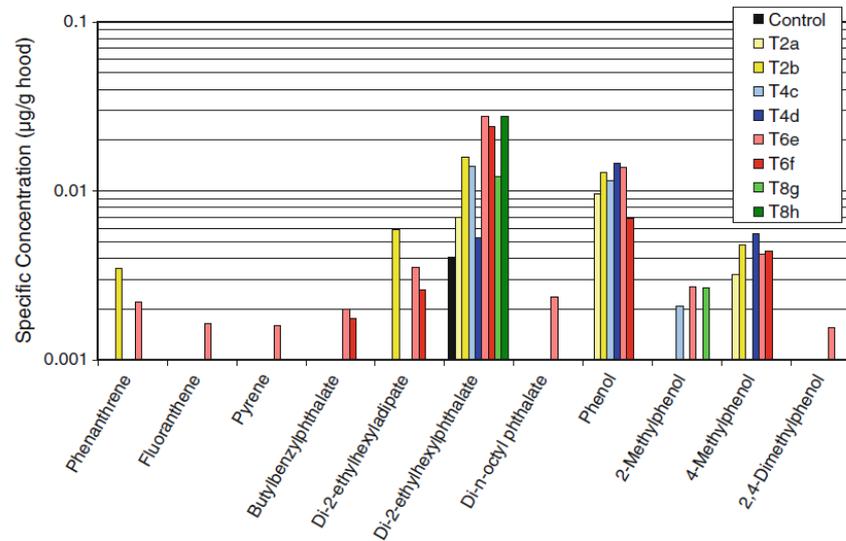
Why an Increase in Prostate Cancer?

- Prostate is a gland tightly regulated by hormones.
- Is there firefighter exposure to **endocrine disruptors**
 - chemicals that interfere with hormone action?

Chemicals found on Firefighter Gloves



Chemicals found on Firefighter Hoods



PAH and other organic compound content of unexposed (control) and exposed firefighter hoods.

Chemical types contaminating Firefighter Gear

- **Plasticizers - phthalate diesters and others.**
Cause testicular and prostate cancers,
Interfere with reproduction and development in animals.
- **Alkyl phenols (plastics additives).**
Interfere with reproduction and development in animals.
- **Polycyclic Aromatic Hydrocarbons (PAHs)**
Cause lung & skin cancer in experimental animals.

Methods: Study Population

- Firefighters:
 - Cincinnati Fire Stations 19 (Corryville).
 - 14 (5th St. Downtown).
- Nonfirefighters:
 - UC Radiation Safety Personnel



Phthalate Diester Plasticizers

- Products of incomplete combustion.
- Dissolve in oil.
- Readily cross the skin.
- Carcinogenic in animals.
- **Endocrine disruptors** – interfere with Development and Reproduction.



Analysis - Gloves



**Used Firefighter Glove 1, showing 3 layers sampled.
The inner layer remains in the glove.**

Analysis - Hoods



Used Firefighter Hood 1, showing square area of sample removal.

Analysis – Coat (wristlet)



Firefighter Coat 1, showing right inner wristlet removed

Analysis - Facepieces



Fire Department SCBA Facepieces, FireHawk® MMR 4500 Ultra Elite®

Study Methods – Gloves, Coats & Hoods

- New and soiled coat, glove and hood samples extracted 2X with 50 ml hexane.
- Extracts evaporated to dryness and analyzed for phthalate ester content.
- Analysis performed by ALS Datachem, Cincinnati, OH by EPA method 8270.

Plasticizer Levels on Gloves & Hoods

	Area Tested	Relative DEHP* level	DMP** level
Unused	Glove Inner	1	ND
	Glove Middle	3	ND
	Glove Outer	3	ND
Used	Glove 813 Inner	229	ND
	Glove 813 Middle	593	ND
	Glove 813 Outer	1000	ND
Unused	Hood	ND	ND
Used	Hood 316	243	ND
Used	Hood 863	122	ND

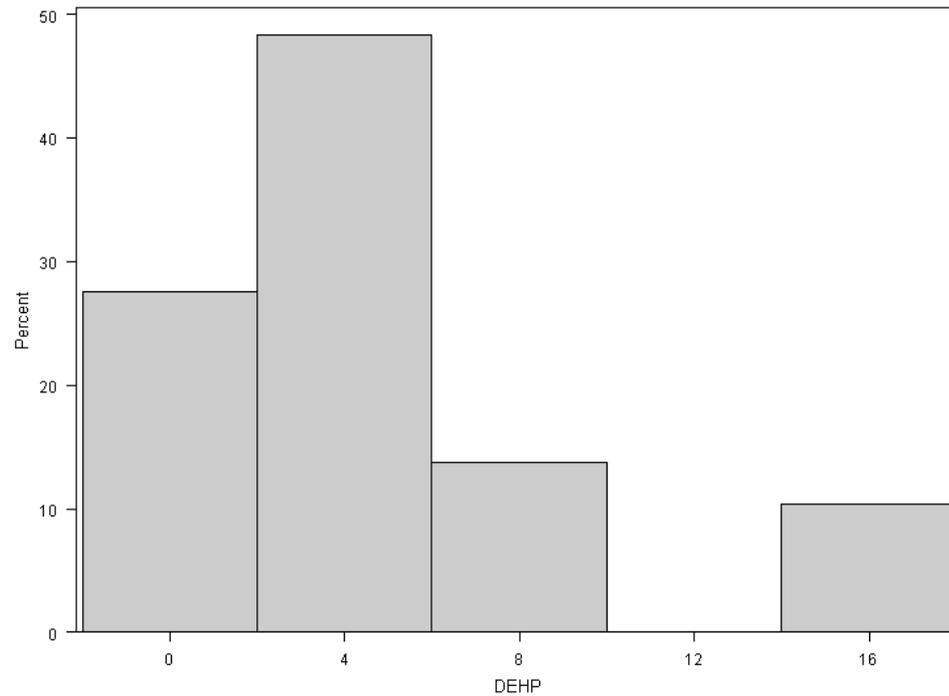
*Bis (diethylhexyl)phthalate.

** Dimethylphthalate.

Study Methods: Facepiece Wipes

- Facepieces were wiped with gauze pads.
- Wipes placed in 2 oz glass jars.
- Analyzed by ALS Datachem, Cincinnati, OH by EPA method 8270.

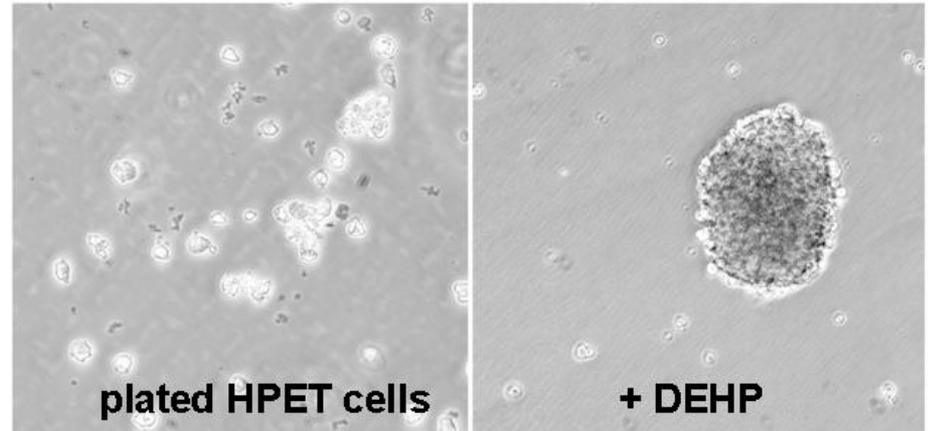
Plasticizer Levels on Facepieces



DEHP levels (micrograms) on 29 wipes of SCBA facepieces in current use.

Are the plasticizer levels found relevant to the increase in prostate cancer risk?

The endocrine disrupting plasticizer DEHP stimulates the growth of human prostate cancer stem cells at very low concentrations:



DEHP concentration (ng/ml)	Total number of spheres per well	Relative Increase
0	16	1
1	119	7.4
10	125	7.8
100	28	1.8

Cardiovascular Disease Risk In Firefighters

Coronary heart disease in firefighters is responsible for:

- 45% of on-duty deaths
- High incidence of premature retirement.

CV events occur 10 – 100X more frequently during fire suppression compared to nonemergency duties.

Fahy RF. U.S. firefighter fatalities due to sudden cardiac death, 1995–2004. Quincy, MA: National Fire Protection Association, June 2005. (Accessed February 21, 2009, at <http://www.nfpa.org/assets/files/PDF/OSCardiacDeath.pdf>.)

Firefighter fatality retrospective study, April 2002. (Prepared for the Federal Emergency Management Agency, United States Fire Service, National Fire Data Center.) Arlington, VA: TriData Corp., 2002.

Kales SN, Soteriades ES, Christophi CA and Christiani DC. Emergency Duties and Deaths from Heart Disease among Firefighters in the United States. *New Engl J Med* 2005;356: 1207 – 15.

Holder JD, Stallings LA, Peeples L, Burrell JW, Kales SN. Firefighter heart presumption retirements in Massachusetts 1997-2004. *J Occup Environ Med.* 2006; 48:1047-53.

Geibe JR, Holder J, Peeples L, Kinney AM, Burrell JW, Kales SN. Predictors of on-duty coronary events in male firefighters in the United States. *Am J Cardiol.* 2008;101:585-9.

Risk Factors for Firefighter CHD

- Personal factors.
- Physical, heat and psychological stresses.
- Extended work shifts.
- Smoke exposure.

Smoke Constituents that May Increase Cardiovascular Disease Risk.

- **Toxic and asphyxiant gases:**
CO₂, CO, CH₄, H₂S.
- **Fine and Ultrafine particles:** PM_{0.25} & smaller.
Exposure associated with cardiovascular changes in several industries & volunteers.
- **Endocrine disruptors** (including plasticizers)
Induce arrhythmia in experimental animals.

Skin as a Route of Exposure

All above chemicals in smoke & soot dissolve **in oil**, not in water, and absorption by the skin is:

- **Fast** for this type of chemical.
- Critically important in exposure.

Skin absorption also:

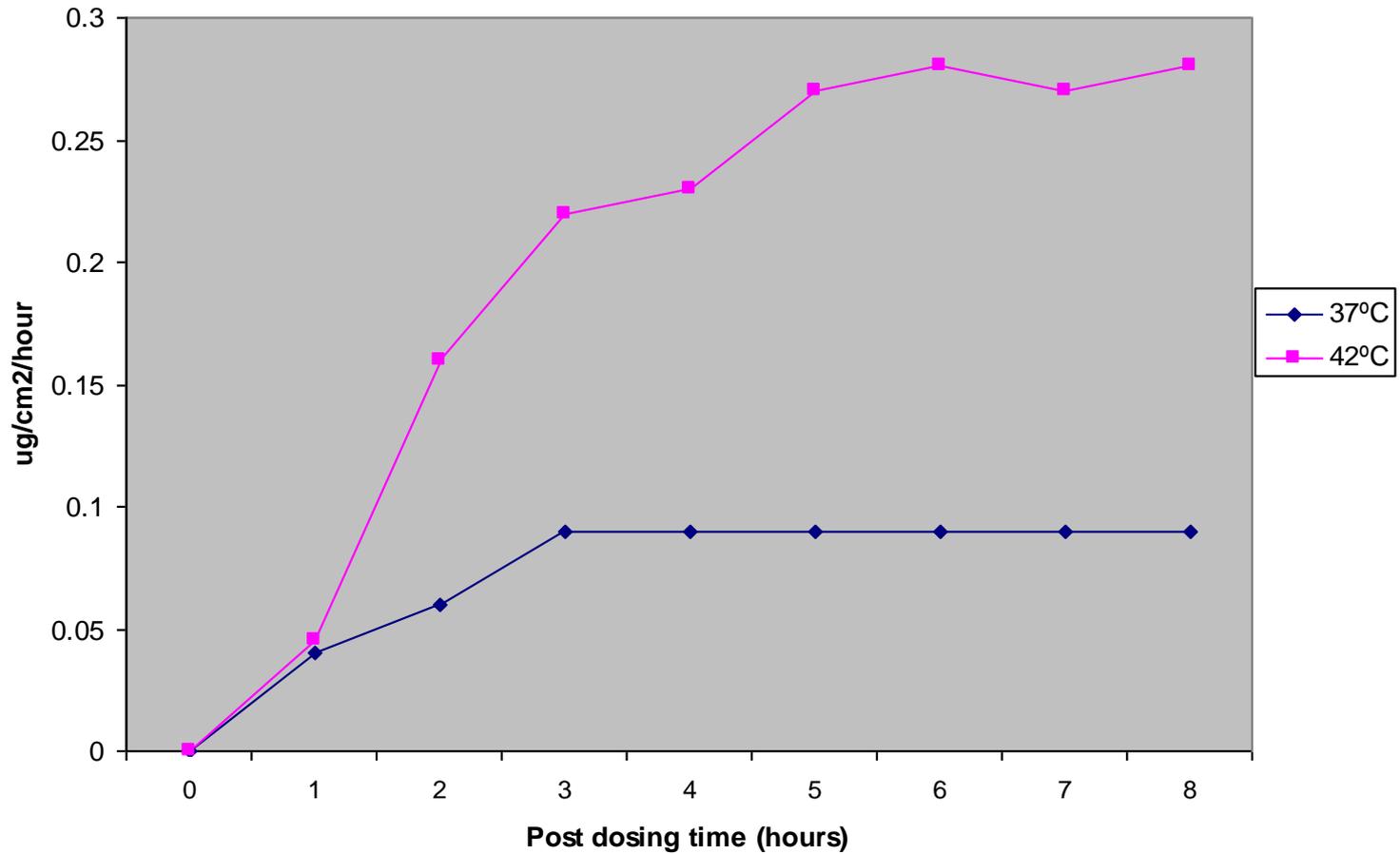
- Varies with anatomic region.
- Increases with temperature.

Skin Absorption Varies By Region

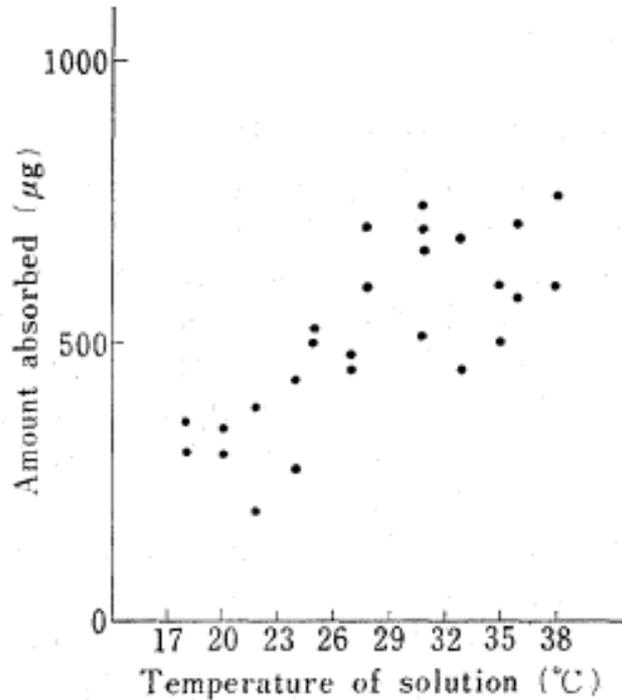
Relative Regional Permeability of Human Skin to Topical Hydrocortisone

Foot arch	1
Lateral ankle	3
Palm	6
Forearm	7
Back	12
Scalp	25
Forehead	43
Jaw angle	93
Scrotum	300

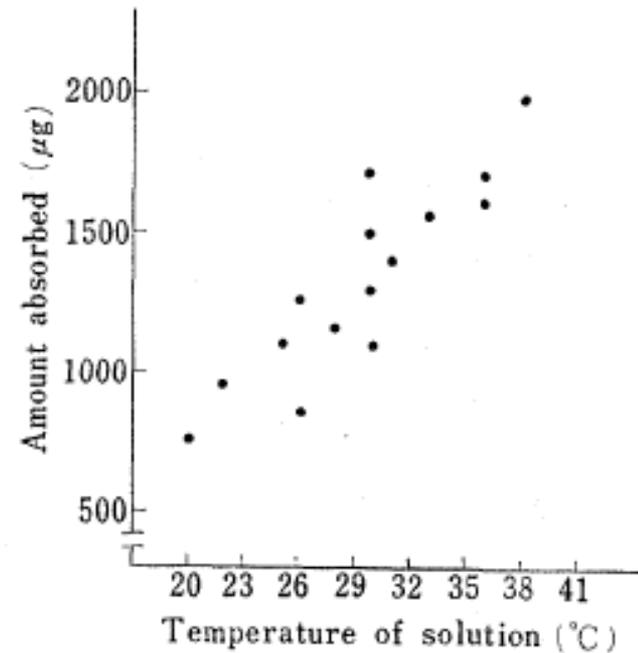
SKIN ABSORPTION RISES STRONGLY WITH TEMPERATURE (PARATHION)



Percutaneous Absorption Increases with temperature

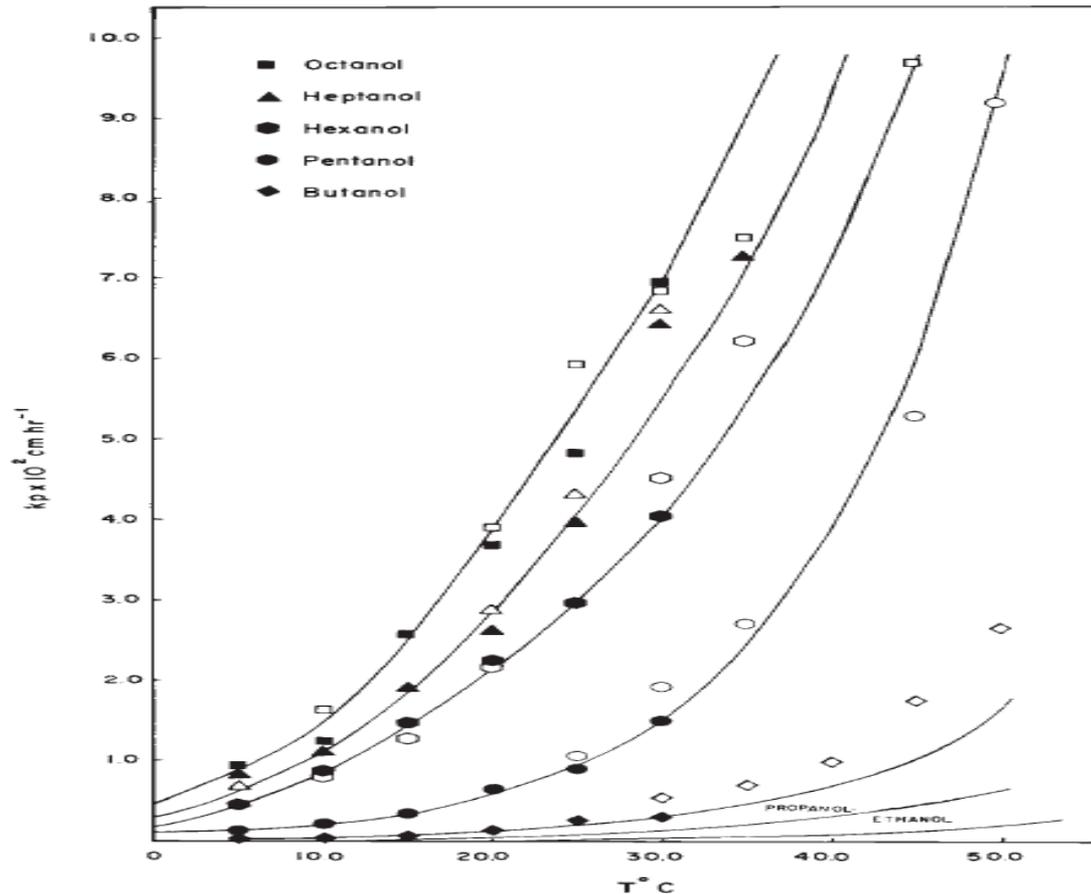


Salicylic Acid



Carbinoxamine

Effect of temperature on Percutaneous Absorption



- Blank IH et al., *J. Invest. Dermatol.* **49**:582, 1967.

Preliminary Conclusions

➤ **Burning materials in modern residential fires produce:**

High phthalate and other plasticizer (endocrine disruptor) contamination of

Firefighter gloves, hoods, clothing and facepieces.

Plasticizer and endocrine disruptor exposure during fire suppression may therefore be a significant contributing factor for the increased risk of prostate cancer in firefighters.

Recommendations

Firefighters exposed to chemicals generated from combustion of synthetic materials face increased risks of:

- **Cancer, including that of the prostate**
- **Heart disease**
- **Adverse developmental outcomes**

These can be potentially avoided by reducing exposure by:

- **Encouraged use of SCBA throughout fire suppression, *including overhaul.***
- **Avoidance of skin contamination during or rapid removal after fire events.**

Chimney Sweeps

- **English chimney sweeps**
 - Very infrequent washing,
– loose clothing.
 - **Scrotal, testicular cancer**
(Pott 1776, Butlin 1892).
- **Belgian, French, Swedish
& German sweeps**
 - Daily washing, tight clothing.
 - **Cancer unknown**
(Butlin, 1892; Gustavsson, 1988, 1993).



Thank you!



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