



Biological Monitoring for Occupational Hygienists BOHS London & South East Region Meeting 19th November 2008

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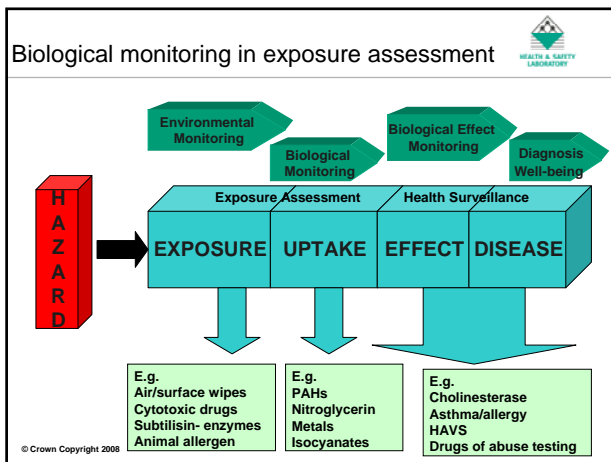
Biological Monitoring

Assessment of overall exposure to chemicals by measurement of the chemicals or their breakdown products in

blood urine and breath




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BM to check the controls work




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The role for biological monitoring

- BM can assess exposure by all routes
 - Inhalation
 - Ingestion
 - Skin Absorption
- BM can assess efficacy of
 - PPE
 - Engineering controls
 - Human factors
 - Regulations / approvals

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Except for Lead, BM is not compulsory but...

- COSHH
 - Assessing risks to Health (regulation 6)
 - Prevent or control risk (regulation 7)
 - Monitoring exposure (regulation 10)
 - Health surveillance (regulation 11)
- COSHH Essentials
 - Hazard Group S – (skin)
 - Hazard Group E (carcinogens and mutagens – some)
 - Maintenance of control – feedback loop
- Good Occupational Hygiene Practice
 - Principle: (f) Check and review regularly all elements of control measures for their continuing effectiveness
 - Control-based Biological monitoring guidance values

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BM for Small Companies



- HSL analyses around 8,000 – 10,000 samples/year
 - ~3,000 for lead (statutory)
 - ~5,000 – 7,000 for 1 or more of >120 different analytes
 - Mostly urine samples
- 80% samples from Non-HSE sources
 - 90% sample requests have <10 names
 - 75% sample requests have <5 names
- Samples sent by
 - Occupational health providers
 - Hygienists
 - Hospitals
 - H & S staff
 - Managers
 - Individuals
- Little contextual data

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Rank Order	Analyte	Guidance
1	Isocyanates	BMGV
2	Blood Lead	CLAW
3	PAHs	BMGV
4	Benzene	BEI/BAT
5	Drugs of Abuse	
6	Chromium	BMGV
7	MDA	BMGV
8	Nickel	EKA
9	Arsenic	BEI/EKA
10	Cholinesterase	MS17
11	Furoic Acid	BEI
12	Mercury	BMGV
13	Cobalt	EKA
14	Thiocyanate	HSL Data
15	Mboca	BMGV
16	Styrene/Ethylbenzene	BEI/BAT
17	Cadmium	BEI/BLW
18	Naphthols	HSL Data
19	Blood Cadmium	BEI
20	Antimony	EKA

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Guidance Values



HSE publishes 15 (+1) BMGVs in EH40 (table 2)

- Recent guidance values – all control-based (not Health-based)
 - Chromium VI
 - PAHs (no WEL)
 - Nitroglycerin (no WEL)
 - Isocyanates
- ACGIH ~ 50 BEIs (Health Based)
- DFG BATs (44), EKAs (20), & BLWs (6)
- Background/unexposed levels
- In-house guidance values

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Polyaromatic Hydrocarbons (PAHs)



PAH's are a group of hydrocarbon compounds with a structure in which 2-6 or more carbon rings are fused together

- PAH's occur naturally and are formed from combustion of organic matter
- Found in a wide range of workplaces
- Thousands of workers may be exposed
- Some(>9) PAHs are carcinogenic

- Clear need to control exposure to PAHs
 - Reduce exposure
 - Reduce risk of ill-health
- HSE Disease Reduction Programme (DRP)
 - Respiratory Diseases (Asthma, COPD)
 - Carcinogens
 - PAHs



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PAHs Baseline Survey 1998

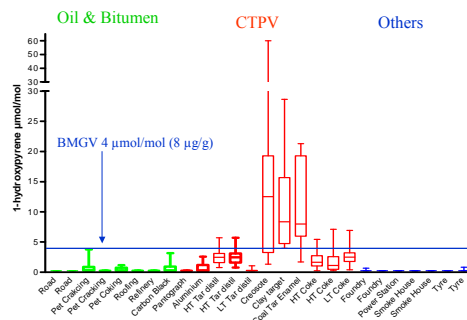


HSE survey in 1998 of 25 workplaces provides a baseline

- Data used by HSE to consider airborne and biological 'limits'
 - Benzo(a)pyrene a good marker of carcinogenic PAHs but no limit set
 - Urinary 1-hydroxypyrene a good marker of exposure to B(a)P
 - Biological monitoring guidance value 4µmol/mol (~8µg/l)
- Biological monitoring useful
 - Dermal absorption
 - Where personal Respiratory Protective Equipment used

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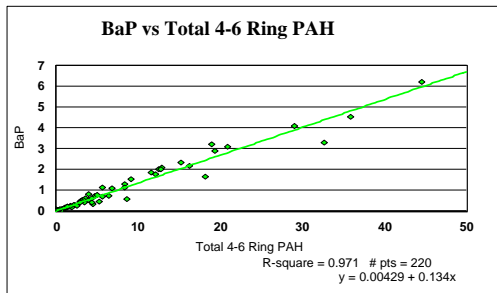
1998 PAH Survey results



Unwin et al 2006 Annals of Occ Hyg

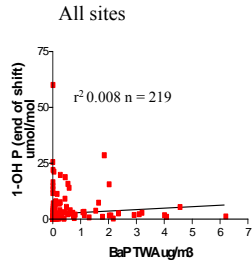
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Airborne PAHs 1998



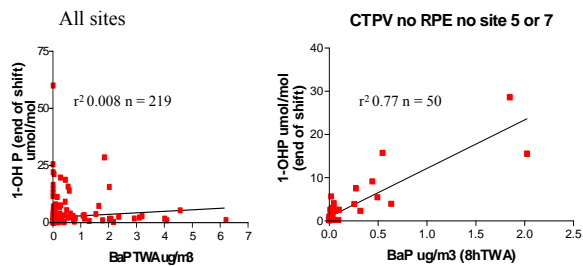
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Urinary 1-OH-Pyrene vs Air BaP



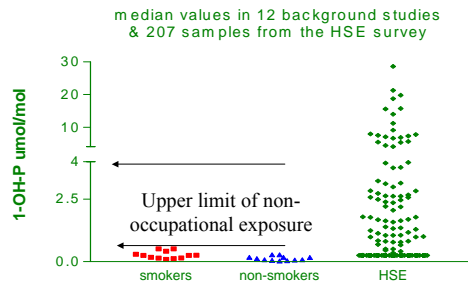
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Urinary 1-hydroxypyrene vs Air BaP



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Urinary 1-hydroxypyrene

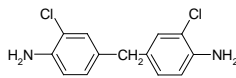


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Case Study - MbOCA



- Aromatic amine
- Suspect carcinogen
- Used for curing polyurethanes
- Low volatility – little inhalation risk
- Absorbed through the skin
- Most workplaces have <10 workers
- Biological monitoring by analysis of MbOCA and its labile conjugates in urine
- HSE and industry together encourage firms to use BM
- Model for the 'Benchmark' or 90th percentile guidance value

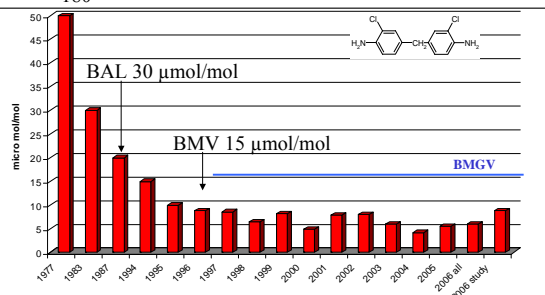


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MbOCA: 90% data from many workplaces



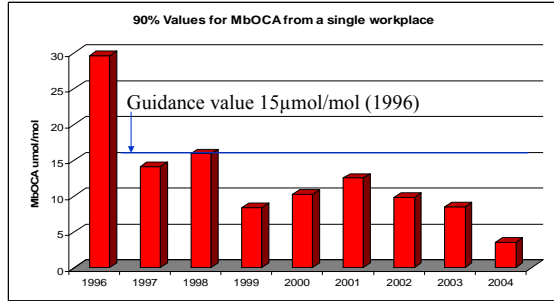
Each bar is the 90th percentile of results from 79 – 400 urine samples from 20 – 35 companies each year



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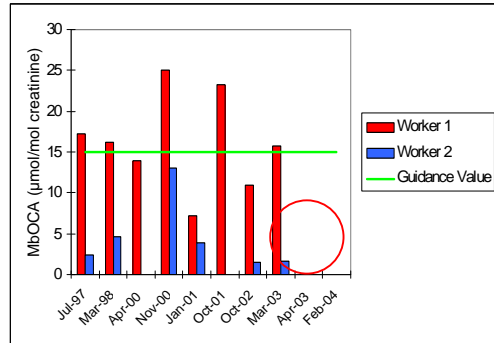
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MbOCA 90% values (one workplace)



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MbOCA : Personal Hygiene



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MbOCA: the feedback loop



- Non-invasive urine sampling
- Inexpensive analysis
- Samples sent by managers, occupational hygienists, & physicians
- Action targeted at the 10% above the guidance value
- Compliance reduces exposure
- Reassuring to workers
- Employers can demonstrate best current practice

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Case Study - Isocyanates



- Widely used: in paints, coatings, polyurethane foams & adhesives
- Respiratory & skin sensitisers
- Biggest cause of occupational asthma in the UK
- HSE Disease Reduction Programme – Respiratory Disease
- Inhalation risk for HDI, TDI, IPDI
- Absorbed through the skin ? TDI, MDI
- BM by analysis of isocyanate-derived diamine metabolites in urine
- WEL low
- Reliance on RPE
- Recent 'Benchmark' or 90th percentile guidance value

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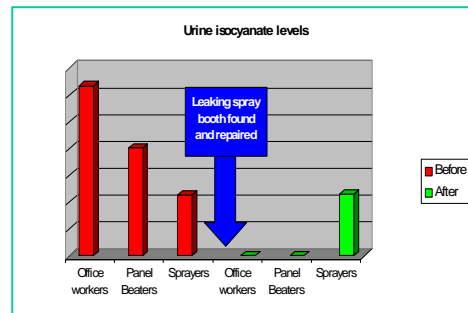
Case study: Isocyanates



- Isocyanates are the biggest cause of occupational asthma in the UK
- Control of exposure relies on RPE
- Is it working and/or being used properly ?

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Engineering Controls and RPE



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BM for Isocyanates



Behaviour:
96% sprayers knew they should not lift their visors **but** 40% admitted to doing so.

BM Guidance value

- 1 $\mu\text{mol/mol}$
- associated with good control
- Exceeding the BMGV triggers investigation of controls

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MVR SHADs



Events emphasise a few key messages:

- Hazards of isocyanates
- Concept of clearance times
- Proper use and maintenance of controls
- Using biological monitoring to check controls
- Need for health surveillance
- What HSE expects



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MVR SHADs



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MVR SHADs



Which mask would you prefer?



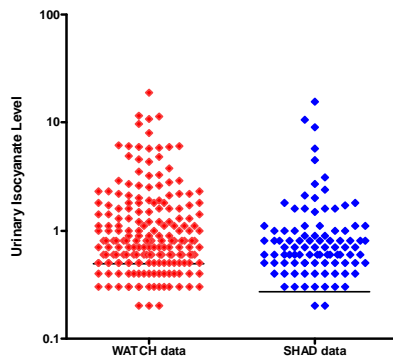
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Check you're not exposed to isocyanates – give a urine sample today



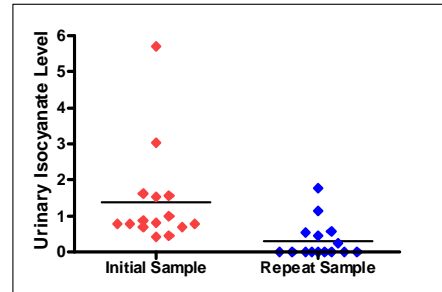
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Did the events work?



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Repeat sampling – Taking Action!



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Case Study - Isocyanates



- BM used to check the efficacy of RPE
- BM used to check worker behaviour
- New 'good-practice' based BMGV for isocyanate-derived diamine metabolites in urine
- Currently being promoted by HSE for paint sprayers
- BM seen as the only practical way to check RPE in the workplace

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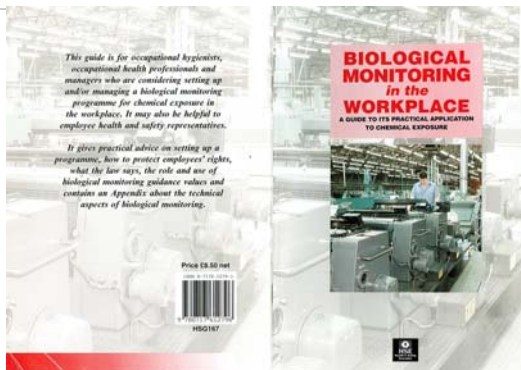
Roles for Biological Monitoring



- Identifying problems
cheaply, simply, remotely
skin exposure/PPE
- Reinforcing good practice
reducing exposure, identifying lapses
- Complementing traditional hygiene tools
routes of exposure

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Setting up a BM programme



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Setting up a BM programme



1. Define the purpose of the programme
2. Appoint a competent person
3. Define the monitoring strategy
4. Consult employees & representatives
5. Discuss & agree with employees
6. Establish procedures for sample collection, transport & analysis
7. Establish procedures for feedback
8. Have arrangements to act on results

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Steps 1 & 2 Purpose & Competent person

- Health Surveillance (COSHH reg. 11)
 - Needs a physician or occupational health nurse
- Exposure assessment (COSHH reg.10)
 - Can be an occupational hygienist or
 - health & safety manager
 - Input from occupational physician recommended, particularly in setting up the BM programme

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Steps 3 & 4 Strategy & Consultation

- Strategy
 - Who to monitor & how often
 - What sample to collect and when
 - Guidance from HSE/HSL, ACGIH, DFG
- Consultation
 - Gaining consent
 - Sample collection
 - Disclosure of results
 - What to do if results show exposure should be reduced

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Step 5 Discuss & agree with workers (Ethics and Consent)

- Protection of the rights of the individual
- Workers must give informed consent
 - BM is voluntary but for their benefit
 - What exposure is being assessed
 - What sample should they provide
 - What will & will not be analysed in the sample
 - Who will see results
 - What the results mean (exposure)
 - What will happen next

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Ethics and Consent

- Acknowledgment of received results

The purpose of this biological monitoring programme and the actions which might be taken to control any excessive levels, have been explained to me by _____ and I

2. The result of my test will be sent to.....

3. Further access to the results will be restricted to the following persons in the indicated forms:

Person to receive results**	Individual results (not anonymised)	Individual results (anonymised)	Group results (anonymised)
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Signature: _____ Date:.....

4. I would/would not* take to receive my own result and have it explained to me.

5. I am / am not* willing for my results to be passed to my family practitioner.

* Tick in appropriate box
** This box should be completed by the programme manager following discussion and agreement with members of their representative. Requests may be approved, pending, health and safety manager, health and safety representative or occupational health staff will be involved in setting the programme.

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Ethics and Consent (5)

PAHs exposure monitoring work details

Please use one of these forms and return with your samples in the bag supplied

Surname:	First Name	Date of Birth	Smoker (please circle) Yes No
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Company and Department (if applicable)

Brief description of the work you did today (please circle one of the descriptions and add any additional information in this box)

I agree to take part in this biological monitoring program of work. I have read and understand the explanatory notes supplied.

Signature	Date
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For laboratory use only

Pre-shift sample Number	Pre-shift result	Post-shift sample number	Post-shift result
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Steps 6, 7 & 8 Strategy, Feedback & Action

- Strategy for sample collection storage, transport, analysis & QA
 - Guidance from HSE/HSL, ACGIH, DFG
- Feedback of results
 - Health surveillance needs a competent occupational physician
 - Exposure assessment needs someone competent in occupational hygiene
 - Physicians helpful if worker reports ill-health or symptoms
- Act on the results

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Biological Monitoring Guidance



- Guidance Documents HSL, ACGIH, DFG
- HSL john.cocker@hsl.gov.uk 01298 21 84 29
- BOHS

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Overall Conclusion



- Biological Monitoring is useful tool for:
 - Assessing exposure
 - Targeting improvements in controls
 - Identifying causative agents
 - Aiding diagnosis
 - Tracking temporal changes
 - Reducing exposure, reducing risk of ill-health
- Go and do some !

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