

Biological Monitoring Without Limits

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- The opinions expressed in this presentation are those of the authors alone and do not necessarily reflect HSE policy

What is Biological Monitoring (BM)

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

blood



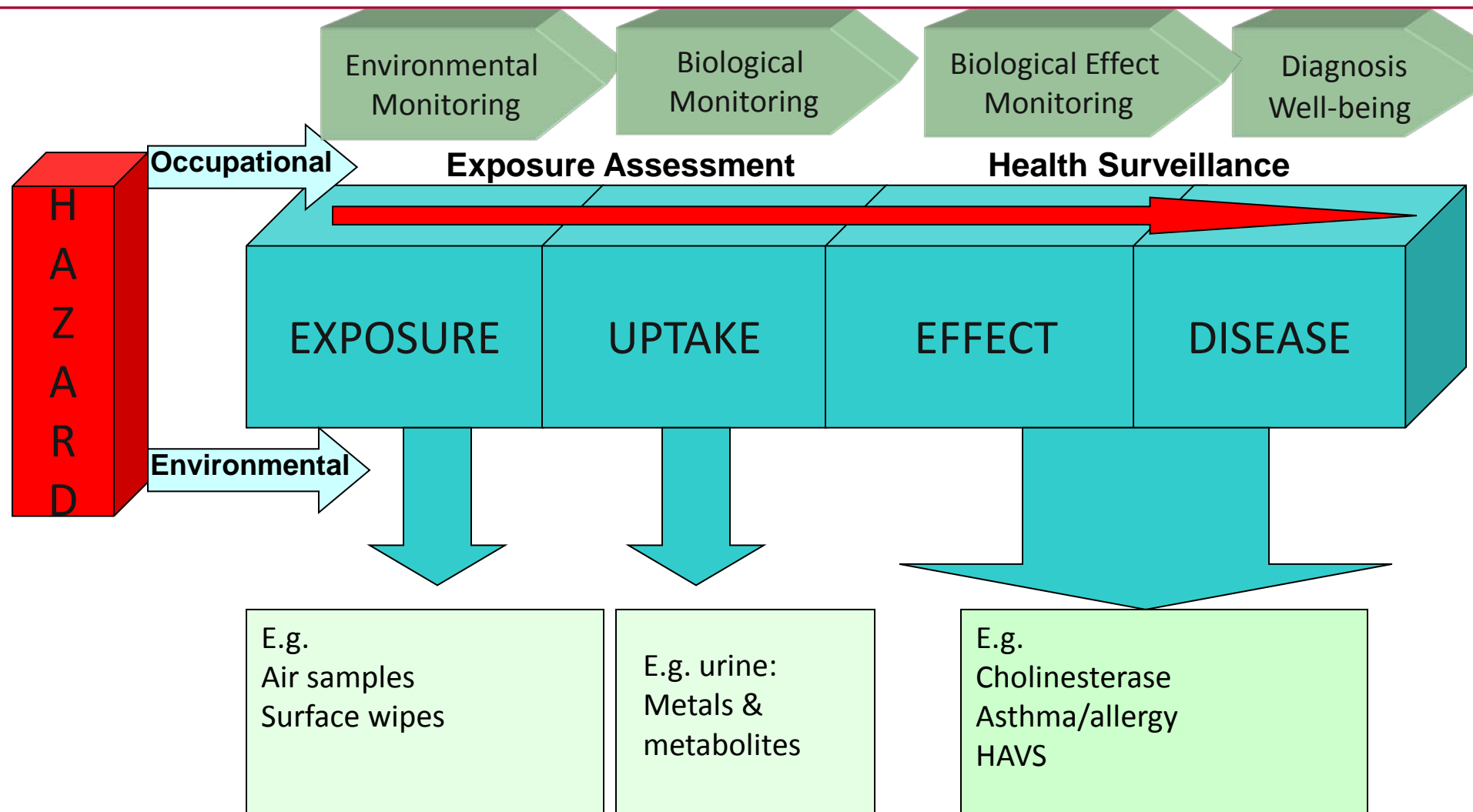
urine



and breath



From Hazard to Disease



The Role of Biological Monitoring



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



BM is a tool for OH Professionals



- Most BM is based on non-invasive urine sampling
- COSHH
 - Monitoring exposure (regulation 10)
 - Health surveillance (regulation 11)
- COSHH Essentials
 - Hazard Group S – (skin)
 - Hazard Group E (some carcinogens / mutagens)
 - Maintenance of control – feedback loop

Biological Monitoring without Limits



BM is a tool for **exposure** assessment

- **Guidance** values available (**not 'limits'**)
 - GB Biological Monitoring Guidance Values (BMGVs 17)
 - American (ACGIH) Biological Exposure Indices (BEIs 47)
 - German (DFG):
 - Biological Tolerance Values (BATs 64),
 - Biological equivalents to airborne limits (EKAs 28),
 - Biological 'lite' values (BLWs 10),
 - Biological reference values (BARs 20)
 - SCOEL
 - BLVs (18)
 - BGVs (4)
 - Background/unexposed levels
- In-house guidance values

BMGVs for carcinogens and sensitisers

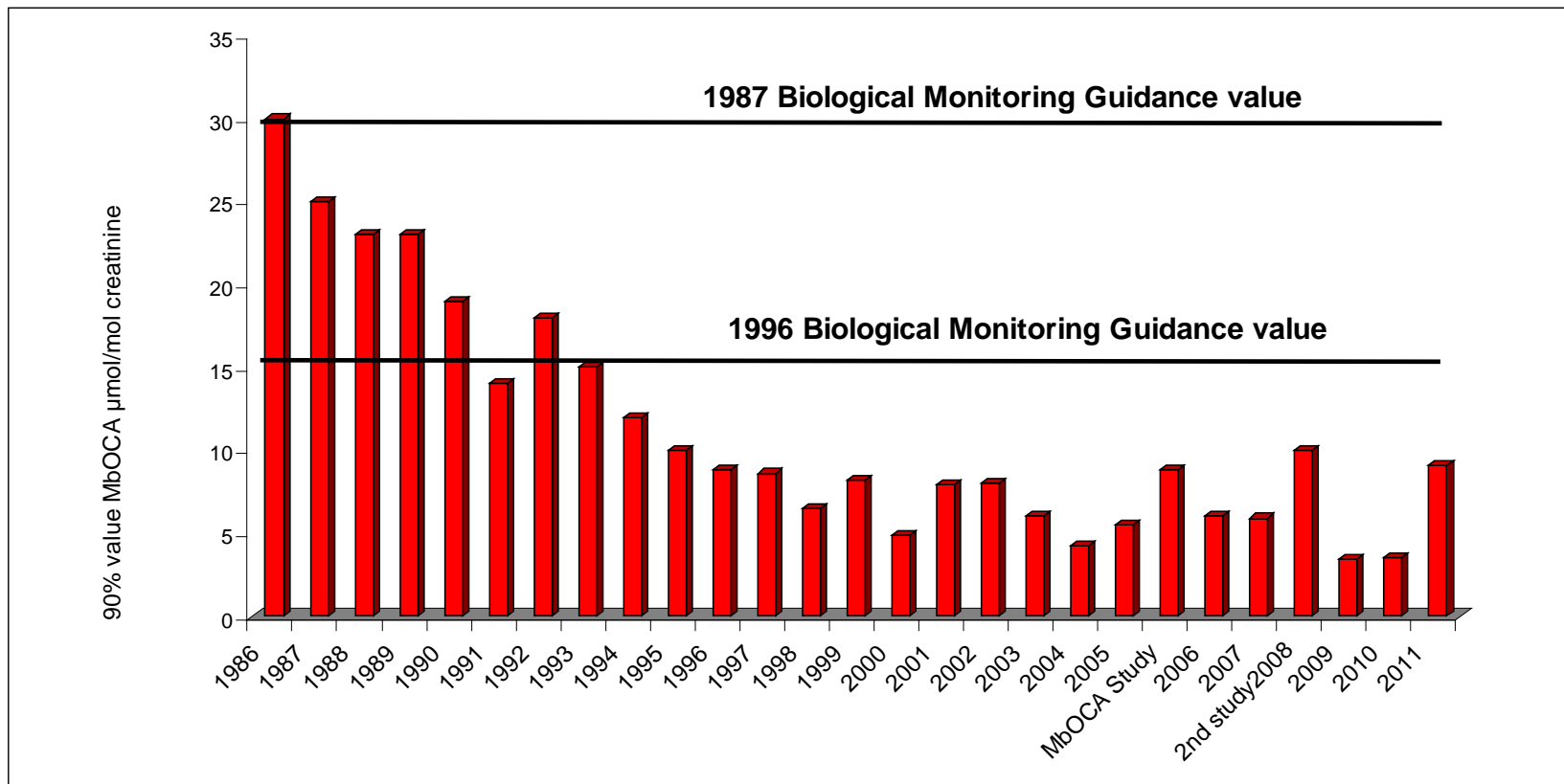
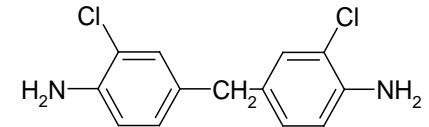


- No threshold or safe level?
- Control exposure to ALARP
 - Background levels = no occupational exposure ?
 - Follow good occupational hygiene practice
 - A numerical value, easy to set & update would be helpful
 - GB has the answer! - a BMGV based on 90% value from workplaces with good control

90% data for MbOCA by year



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



Good-practice-based BMGVs



Other ‘benchmark’ values based on the 90th percentile of data from workplaces with good control of exposure:

- Chromium VI
- Glycerol trinitrate (Nitroglycerin)
- Isocyanates
- 4,4’-Methylenedianiline (MDA)
- Polycyclic aromatic hydrocarbons (PAHs)

HSL Biological monitoring database



- Collecting data since 1996
- Samples come from:
 - HSE/L
 - Occupational health providers
 - Occupational hygienists
 - Workplace H & S staff
- Except for HSE/L samples little contextual data
- Over 20 years >240,000 results

HSL BM Data



- Could be biased upwards from companies with difficulties controlling exposure
- Could be biased down if only 'good' firms send samples
- Samples from HSE surveys of workplaces following good OH practice show similar results

HSL P90 Data



Substance (Analyte) units	Number of Companies	Number of Results	HSL P90 value	Guidance value	Source
HDI (HDA) $\mu\text{mol/mol}$	968	12337	0.6	1	HSE
IPDI (IPDA) $\mu\text{mol/mol}$	967	12168	<0.5	1	HSE
TDI (TDA) $\mu\text{mol/mol}$	390	3441	<0.5	1 ~5	HSE ACGIH
MDI (MDA) $\mu\text{mol/mol}$	891	11269	<0.5	1 ~4	HSE DFG-BLW
MbOCA (MbOCA) $\mu\text{mol/mol}$	27	364	7.2	15	HSE
Methylenedianiline (MDA) $\mu\text{mol/mol}$	10	1098	5.2	50	HSE

HSL P90 Data



Substance (Analyte) units	Number of Companies	Number of Results	HSL P90 value	Guidance value	Source
Xylene (MHA) mmol/mol	64	894	<1	650 900	HSE ACGIH
PAH (1-OHP) $\mu\text{mol/mol}$	32	2861	6.1	4	HSE
Lead (Pb in Blood) $\mu\text{g/dl}$	248	5876	31	50 30	HSE- CLAW ACGIH
Cadmium (Cd) $\mu\text{mol/mol}$	52	926	0.8	~4	ACGIH
Cobalt (Co) $\mu\text{mol/mol}$	58	118	7.6	~20	ACGIH
Chromium (Cr) $\mu\text{mol/mol}$	200	4110	4.6	10 ~40	HSE ACGIH

HSL P90 Data



Substance (Analyte) units	Number of Companies	Number of Results	HSL P90 value	Guidance value	Source
Mercury (Hg) $\mu\text{mol/mol}$	96	263	3.1	20 11	HSE ACGIH
Nickel (Ni) $\mu\text{mol/mol}$	128	2583	18	60	DFG-BAT
Beryllium (Be) ng/l	7	280	36	50	DFG-BAR

HSL ninetieth percentile data 2012-2015 for analytes with >100 results

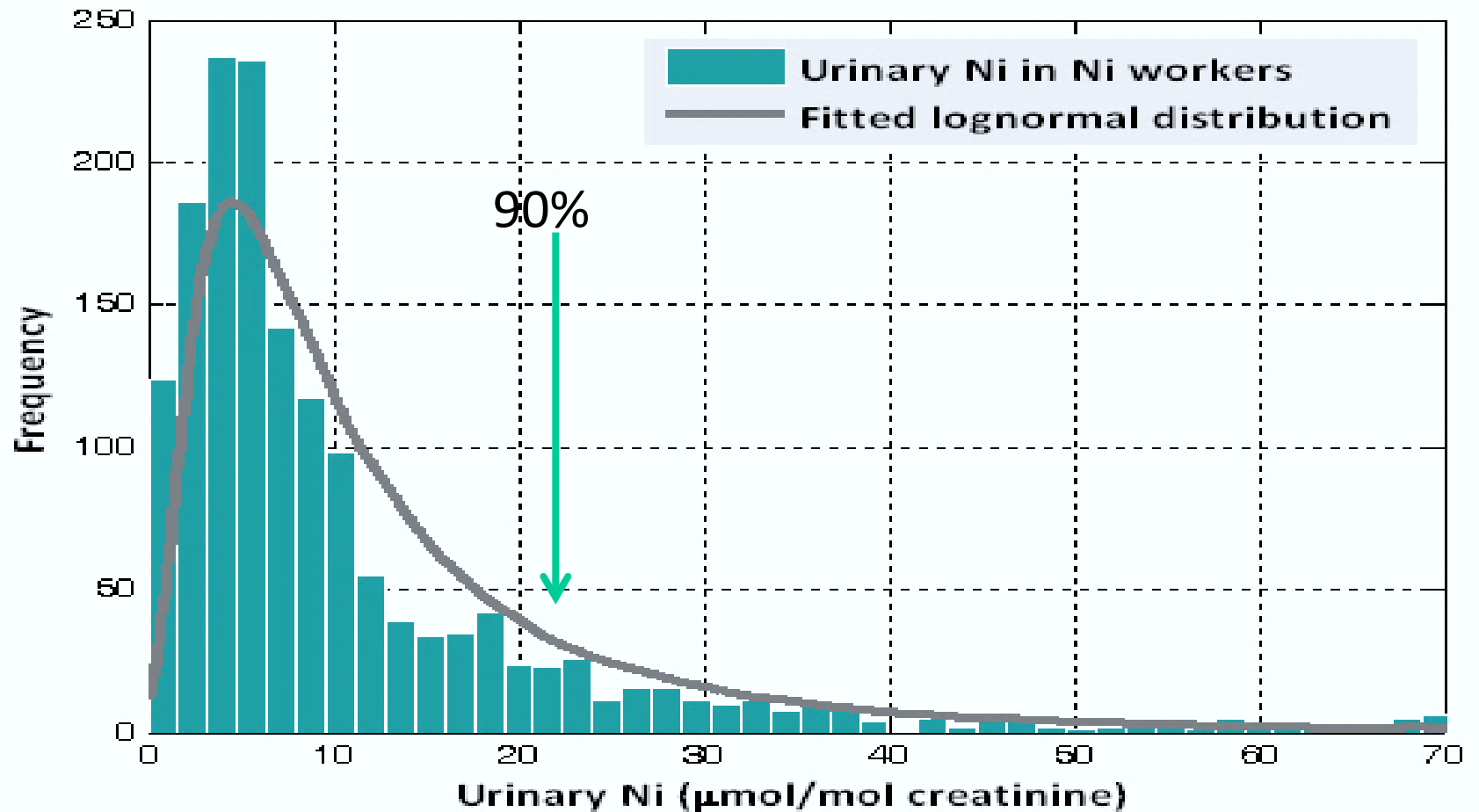
HSL P90 data vs HSE survey of exposure in UK electroplating industry



- Occupational Hygiene survey of 53 sites 2008 – 2011
- Biological Monitoring of exposure to Cr_{vi} & Ni
- Workers gave samples on 3 consecutive days 3x, initial survey, 6 and 12 month follow up
- 282 Nickel workers, 1619 samples
- 237 non-nickel workers, 1219 samples
- 354 Chromium workers, 2079 samples
- 152 non-chromium workers, 706 samples

Beattie H et al. J Exp Sci & Env Epi 2015 1-9

Urinary Nickel results



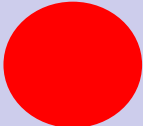


HSL P90 data vs HSE survey results



Substance (Analyte) units	HSL P90 Before	Survey P90 (all)	HSL P90 After	Guidance value	Source
Nickel	24	21	23 (18 now)	100	DFG EKA
Chromium vi	-	9	5	10	HSE

Electroplating Survey “Traffic Lights”



Traffic Light	Chromium $\mu\text{mol/mol}$	Nickel (soluble) $\mu\text{mol/mol}$	Comments
	>40	>100	BM exposures equivalent to UK WELs. Collect further samples & check controls urgently
	10-40	24-100	BM results over guidance value. Collect further samples and check controls
	<10	<24 (P90 HSL data)	BM results below guidance values
Background Level	3	10	95% value for non-occupationally exposed

Beattie H et al. J Exp Sci & Env Epi 2015 1-9

HSL: HSE's Health and Safety Laboratory

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In-House BMGVs



- 90% value based on GOHP
- Use:
 - to check controls
 - PPE
 - Behavioural
 - Monitor progress/improvements

Summary



- BM is a tool to help assess exposure
- BM Guidance values NOT limits
- 90% BMGVs linked to good OH practice
- 90% BMGVs linked to 'ALARP'
- 90% value concept applicable to in-house BMGV
- HSL's 90% values < published BMGVs

Thank you for listening



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