

Reflections on the Future Practice of Occupational Hygiene

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San Diego, California

Overview

- The transition (1990-2005)
- The next era (2005-2020)
- Topics that will likely dominate our field
- Four actions that would alter our future



The Transition (1990-2005)

- In large measure, in Western society, occupational diseases were dramatically decreased
- Self-compliance was common among large companies
- Some biological monitoring was implemented
- Much of the “dirty” and difficult manufacturing began to move to less industrialized countries
- Many occupational hygienists moved into environmental health



The Next Era (2005-2020)

- Greater number of hazardous occupations were moved off-shore
- Focus moved to sensitizers, developmental and reproductive toxicants, lung toxins, etc.
- Small particles become major initiative
- Biological monitoring and biomarkers become as important as air sampling



Anticipating What Will Be Important to Society (and Hygienists) in the Next Decade



Some Predictions (2008-2020)

- Tier I
 - Global warming
 - Small particles
 - Nanotechnology
 - Mixtures
 - Sensitizers (beryllium)
 - Biological monitoring
 - POPs (dioxins, brominated, fluorinated and PAH compounds)
- Tier II
 - Lead
 - Mercury
 - Pesticides
 - Benzene (and simulation studies)
 - Popcorn lung
 - Retrospective exposure assessment

Tier I (2008-2020)



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7

Global Warming

- It is unclear how occupational hygienists will participate in the debate or response
- As we have seen in California, various countries and specific regions will likely identify voluntary goals
- Over time, many of these goals will likely be incorporated into trade agreements
- More research needed to identify the chemicals, key particles, and combinations of agents worthy of regulation



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8

Small Particles in Air

- Research on small particles and the associated level of concern has escalated steadily since about 1995
- Magnitude of impact on human health is not well understood...but government considered important
 - What size particles are responsible, specific chemicals of concern, the effects of mixtures, etc.



Nanotech – What is it about?

- “Involves a wide range of technologies that measure, manipulate, or incorporate materials and/or features with at least one dimension between approx 1 and 100 nanometers (nm).” (ASTM International, 2006)
- Dozens of consumer product companies already employ nanotechnology advances in their offerings
- Major advancements are expected soon
 - Imaging
 - Electronics
 - Energy
 - Therapeutics



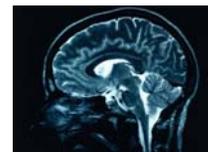
Which Products?

- Consumer products
 - Suntan lotion
 - Cosmetics
 - Waterproof clothing
- Industrial products
 - Coatings
 - Electronics
- Medical applications
 - Drug delivery
 - Biosensors
 - Novel anticancer therapies



Anticipated Claims and Concerns

- Sensitization
- Heart disease
- Ocular effects
- Renal disease
- Pulmonary effects
- Neurologic effects
- Cardiovascular disease

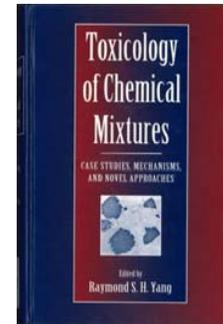


Recent Occupational Health Activities Regarding Nano

- 1st international conference on occupational health and nano held in 2006 in Cincinnati
- A lot of active and proposed research
- Workers have generally not been the focus of most concern; it has been the public
- Interestingly, no regulatory initiative by any occupational health agency has occurred

Mixtures

- After 30-40 years, this has moved to forefront
- WHO and the U.K. are currently rewriting guidance, with U.S. EPA to follow
- No uniform agreement on the best approach, but NGOs see it as a serious weakness in occupational and environmental regulatory policies...e.g., why regulate a single chemical?



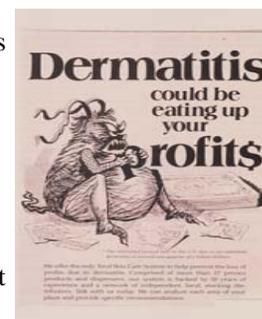
Sensitizers

- The apparent increase in food and chemical allergies has surprised the medical community
- No single explanation is apparent
- In the workplace, TDI, large molecules (pharmaceuticals), and certain metals (like beryllium), will receive much attention



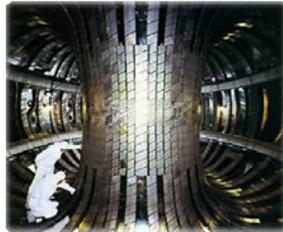
Absorption Through Skin...Part of the Sensitizer Issue

- Clearly, one of the evolving areas in occupational hygiene
- Exposure limits, biomonitoring, personal protection dermal sampling, and wipe samples will be a part of the practice of occupational hygiene
- Sensitizers will be the driver...but systemic toxicants will follow



Beryllium Is Different!

- Significant litigation in the 1990s involving government workers in the U.S.
- Chemical causes a unique lung disorder called “Chronic Beryllium Disease” (CBD)
- Microscopic airborne concentrations can result in “sensitization” of susceptible individuals (1-4% of population) which sometimes leads to CBD



Beryllium

- The situation has changed...
- Reports have surfaced since 2003 that possibly thousands of people have become sensitized and are unaware
- Targeted Industries:
 - Beryllium processing companies
 - Metals recyclers
 - Electronics and semiconductors



Beryllium....Future Concerns

- Take-home claims likely to increase; spouses of government workers could be focus of attention
- Impact to downstream users deserves some study...especially metal recyclers
- Safe levels of occupational workplace are not clear
- Very large differences in individual susceptibility



ChemRisk® Beryllium Publications

Applied Occupational and Environmental Hygiene
Volume 34(3) 227-238, 2003
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1041-3223/03 \$12.00 + .00

Identifying an Appropriate Occupational Exposure Limit (OEL) for Beryllium: Data Gaps and Current Research Initiatives

Dennis J. Paustenbach, Amy K. Madl, and Jessica F. Greene
Exponent, Menlo Park, California

Applied Occupational and Environmental Hygiene
Volume 34(3) 261-264, 2003
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1041-3223/03 \$12.00 + .00

A Comparison and Critique of Historical and Current Exposure Assessment Methods for Beryllium: Implications for Evaluating Risk of Chronic Beryllium Disease

Marc E. Kolansky,¹ Amy K. Madl,² Michael A. Kolish,³ Michael S. Kratz,⁴ Renee M. Kohnen,² and Dennis J. Paustenbach²
¹Brask Wilmann Inc., Cleveland, Ohio; ²Exponent, Menlo Park, California; ³Brask Wilmann Inc., Elyria, Ohio

Int Arch Occup Environ Health
DOI 10.1007/s00420-007-0202-3

ORIGINAL ARTICLE

Performance of the beryllium blood lymphocyte proliferation test based on a long-term occupational surveillance program

Ethan P. Donovan,¹ Marc E. Kolanz,² David A. Galkovich,³ Pamela S. Chapman,⁴ Dennis J. Paustenbach

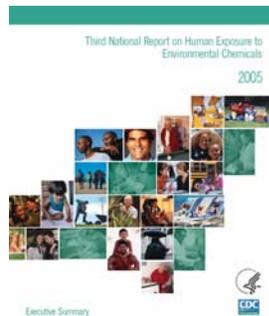
Applied Occupational and Environmental Hygiene
Volume 34(3) 265-270, 2003
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Contribution of Incidental Exposure Pathways to Total Beryllium Exposures

David C. Deubner,¹ Yvette W. Lowrey,² Dennis J. Paustenbach,³ and John Warnerham⁴
¹Brask Wilmann Inc., Elyria, Ohio; ²Exponent, Boulder, Colorado; ³Exponent, Menlo Park, California

Biological Monitoring

- Probably the single most important “new thing” in occupational and environmental health
- Beginning about 10 years ago, analytical techniques allowed for trace quantities of 300 substances to be measured in blood and urine
- U.S. CDC/NCEH has pioneered the approaches and reports through NHANES every 2-3 years
- The impact on social awareness and activism has begun and will create a sea change in expectations



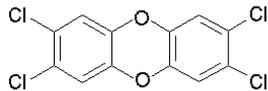
Flame Retardants

- Beginning in late 1980s, they were found to be distributed globally (humans and wildlife)
- In late 1990s, found that blood levels were increasing in humans...one of the few chemicals to do this
- Several were voluntarily removed from market
- The concern is persistence and possible endocrine activity



Dioxin

- Described as the “most toxic chemical known to man”
 - (although it is not known to have been responsible for any deaths)
- Can be measured in every human
- Actively litigated from 1979 – 1994
- Most cases involved aerial emissions from combustors and contaminated sediments



Dioxin

- Beginning in 2003, many new legal cases filed in the U.S.
- Allegations ranged from nearly any type of cancer to diabetes
- Most claims involved persons living in cities near incinerators, chemical manufacturers, and paper mills
- Targeted industries:
 - Chemical companies
 - Utility companies
 - Metal recyclers
 - Municipal waste incinerators
 - Wood treatment facilities
- Interest has moved to workers



Dioxin

- Biological monitoring of workers will be the driver of concern...for dioxins and other POPs



Tier II (2008 – 2020)



Lead

- Although a chemical of concern for nearly 80 years, it remains on the priority list in most countries
- In the developed countries, biological monitoring has helped identify target populations
- Expect continued systematic reduction through engineering and administrative controls...as well as continued research for effects on children and the aged



Mercury

- Similar to lead, it has been studied for nearly 100 years in the workplace and the environment
- No doubt, like small particles, various regional governments will place limits on emissions and airborne concentrations...and, over time, expectations will be embedded in trade agreements
- The ultimate concern will be international transport and deposition to waterways, aquatic species, and the ambient air



Popular Science Monthly, April 1939 printed an article entitled "Fun with Quicksilver," in which a technique to clean up spilled mercury is described by sucking it up with one's mouth.

Concerns about lead and mercury will migrate to concerns about manganese, zinc, chromium, and “rare” metals used in computers...and the concern will be about “other kinds” of diseases.

Autism

- Concerns have already been raised
- Is it diagnosis, classification...or a real change?
- Might industrial chemicals play a role in this disease?



Pesticides

- Clearly there will be pressure to “use less” and sell fewer products
- Biomonitoring will drive most initiatives
- New, more-subtle effects will be claimed
- One way or the other, exposures of workers and community will continue to decrease in the coming years



Renewed Interest in Benzene

- From 1978-1994 in the U.S., legal cases involved relatively high doses
 - Exposures were often 1 to 20 ppm-yrs
 - Focus was AML
- In 2005-2006, more than 100,000 new cases filed in the U.S.
- Recent filings have focused on “trace” exposures
 - Cumulative doses often 0.01 to 1 ppm-yrs



Simulation Studies Can be Helpful in the New Era

- Prior to 1990s
 - Typically extrapolated from incomplete or poorly correlated data in the literature to estimate worker or environmental exposures
- Simulations have now evolved into carefully designed studies
- Within the litigation setting, simulation studies can
 - Characterize legitimacy of claims
 - Provide a strong scientific statement on risk



Why Simulation Studies Are Helpful

- When historical data are not available, they can fill data gaps in the likely exposure history of a worker
- Best when adequate information and equipment exist to reconstruct the event or task
- Data usually improves the quality of the exposure component of an epidemiology study



ChemRisk® Benzene and Simulation Publications

Journal of Occupational and Environmental Hygiene, 4, 373-381
 ISSN 1545-7632 print / 1545-7633 online
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 DOI: 10.1080/15457630701448642

Airborne Concentrations of Benzene Associated with the Historical Use of Some Formulations of Liquid Wrench

Pamela R.D. Williams,¹ Jeffrey S. Knutsen,² Chris Atkinson,¹
 Amy K. Maul,³ and Dennis J. Paustenbach²
¹ChemRisk, Boulder, Colorado
²ChemRisk, San Francisco, California

Journal of Toxicology and Environmental Health, Part A, 43, 1945-1964, 2002
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 ISSN 1093-7207 print / 1093-7208 online
 DOI: 10.1080/10937200208710487

AIRBORNE CONCENTRATIONS OF BENZENE DUE TO DIESEL LOCOMOTIVE EXHAUST IN A ROUNDHOUSE

Amy K. Maul
 Exponent, Santa Rosa, California, USA
 Dennis J. Paustenbach
 Exponent, Menlo Park, California, USA

Journal of Toxicology and Environmental Health, Part A, 43, 1965-1976, 2002
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 ISSN 1093-7207 print / 1093-7208 online
 DOI: 10.1080/10937200208710490

AIRBORNE CONCENTRATIONS OF BENZENE AND MINERAL SPIRITS (STODDARD SOLVENT) DURING CLEANING OF A LOCOMOTIVE GENERATOR AND TRACTION MOTOR

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 Exponent, Menlo Park, California, USA

Journal of Occupational and Environmental Hygiene, 2, 386-396
 ISSN 1545-7632 print / 1545-7633 online
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 DOI: 10.1080/15457630701448642

Benzene Exposures Associated with Tasks Performed on Marine Vessels (Circa 1975 to 2000)

Pamela R. D. Williams,¹ Kathryn Robinson,² and Dennis J. Paustenbach²
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²ChemRisk, San Francisco, California

Journal of Occupational and Environmental Hygiene, 2, 361-370
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Characterizing Historical Industrial Hygiene Data: A Case Study Involving Benzene Exposures at a Chemical Manufacturing Facility (1976-1987)

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¹ChemRisk, Boulder, Colorado
²ChemRisk, San Francisco, California

Diacetyl and “Popcorn Lung”

- In November 2000, NIOSH conducted the first Health Hazard Evaluation (HHE) at Gilster-Mary Lee Popcorn Plant in Jasper, Missouri



- Diacetyl was identified as the most likely chemical for causing bronchiolitis obliterans, as well as other lung diseases

- NIOSH has conducted HHEs at a total of at least nine microwave popcorn plants throughout the US



Manufacturer Response

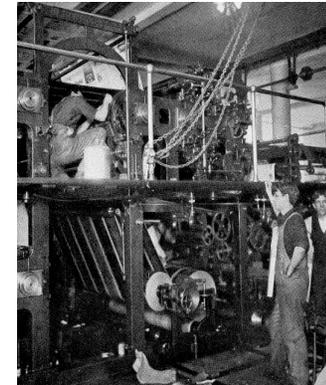
ConAgra Foods, General Mills, and American Popcorn Company have announced the removal of diacetyl from their products

- *“The three companies that sell Orville Redenbacher, Act II, Pop Secret and Jolly Time microwave popcorn said they planned to change the recipes for their butter-flavored microwave popcorn to remove diacetyl.”*
(NYT – 9/6/2007)



Retrospective Exposure Assessment

- Collection of actual IH data, simulation studies, and analogous exposure scenarios to estimate air borne concentrations
- Coupled with job descriptions and time-and-motion data
- Estimate each worker's (or job class) lifetime dose



Why?

- Epidemiology will drive most future decisions about human health risks
- Dose has historically been the weak link in these studies

RE-EVALUATION OF BENZENE EXPOSURE FOR THE FLOETON RUBBERWORKERS COHORT (1936-1976)

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American Petroleum Institute, Washington, D.C.

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American Petroleum Institute, Washington, D.C.

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ChemRisk, A Division of McLaren/Hart, Springfield, Missouri

H. D. Peterson
Bryant, Cave, McFheeters & McRoberts, Washington, D.C.

The Floeton cohort is the most intensely studied group of workers chemically exposed to benzene. Information on the cohort has been the basis for regulatory and public debates for occupational and environmental exposure to benzene. Study of the 1960s, 1965 and Camp and Allen (1986) developed different approaches for reconstructing the exposure history of each member of the group. The predicted levels of exposure, combined with the data on the incidence of disease, have been used to estimate benzene's carcinogenic potency. In this paper, recent information from worker interviews and historical records from the Federal Archives and elsewhere were used to evaluate the accuracy of prior exposure estimates and to develop better data for the cohort. The following factors were evaluated for 15 years of benzene dose to short-term, high-level exposure to agents 10 weeks later to background concentrations in the manufacturing building, 10 weeks later to contact with the slush, the mobility and mortality data on workers in the Floeton process, 10 the installation of industrial hygiene engineering controls, 10 exceptionally long work weeks during the 1960s, 10 data indicating that airborne concentrations of benzene were underestimated due to inaccurate monitoring devices and the lack of adequate leak protection.

Requests for reprints should be sent to Dennis J. Paustenbach, ChemRisk, A Division of McLaren/Hart, 1335 Alameda Avenue, Alameda, CA 94601.

177

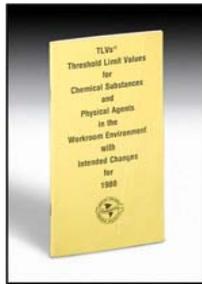
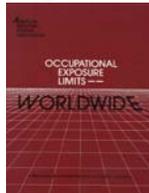
Journal of Toxicology and Environmental Health, 36:177-231, 1992
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Four Actions That Would Dramatically Change Our Field



Action 1: Develop New OELs

- Most current OELs are based on old risk criteria
- Many based on toxicity database now considered incomplete
- Much lower OELs would dramatically alter the profession



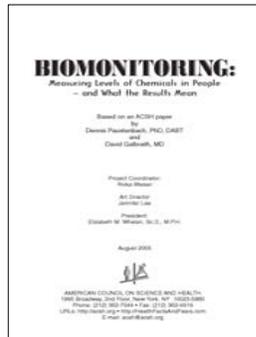
Action 2: Improve Sampling Techniques

- To meet the “modern era” OELs, much better techniques will be needed
- Passive and/or microtechniques will be expected (and available)
- 8-24 hour sampling will be commonplace



Action 3: Guidelines for Biomonitoring

- New OELs will dictate a “Sea change”
- If hygienists and toxicologists don’t lead on interpretation, the public will dictate the response to these new data
- Leadership will be critical...perhaps through an international panel



Action 4: Identify Uniform Risk Criterion

- On the global stage, harmonized risk criteria would be helpful
- Not likely until developing countries want to participate
- Trade agreements could force the issue



Closing

- The field will continue to evolve very quickly... so we must be attentive to changes in the science and societal expectations
- Occupational hygiene has not done this well for nearly 30 years...at least four professional societies have “spun out” of our field
- As Pasteur said:



“...chance favors only the prepared mind”