International Society of Exposure Sciences –
International Society for Environmental Epidemiology
(ISES-ISEE 2018)

26 to 30 August, 2018

Two (out of many) Presentations of Interest
Topics and Credits

• *The Role of Occupational Studies in Expanding our Knowledge* - Paul A. Demers, PhD, Occupational Cancer Research Center

The Role of Occupational Studies

• International Agency for Research on Cancer (IARC) is a specialized agency of the United Nations.

• Associated with the World Health Organization (WHO)

• IARC conceived a program in 1970 to provide advice on environmental carcinogens. Factors include...
  – Chemicals and complex mixtures
  – Physical and biological agents
  – Occupational, environmental, lifestyle exposures
The Role of Occupational Studies, *cont’d*

- IARC scientific working groups are a technical resource to national agencies to prevent exposure to potential carcinogens

  - Volume 1 - Some Inorganic Substances, Chlorinated Hydrocarbons, Aromatic Amines, N-Nitroso Compounds, and Natural Products (e.g., beryllium, carbon tetrachloride, cycasin, dihydrosafrole, *etc.*).
  - Volume 123 (Pending) - Nitrobenzenes

- LARC’s classifications contribute to prevention by:
  - Stimulating regulations, guidelines, and policies (occupational Exposure Limits, labeling, toxic use reduction...)
  - Encouraging voluntary actions by employers and/or workers
  - Raising awareness, but...
The Role of Occupational Studies, *cont’d*

IARC Carcinogen Categories – 1006 agents studied in total

- **Group 1**: Carcinogenic in humans (120 agents)
  - *Almost always requires strong human (epidemiologic) evidence*
  - *Examples: Formaldehyde, Cr VI compounds, Asbestos, Erionite, Mustard Gas*

- **Group 2A**: Probably carcinogenic in humans (82 agents)
  - *Generally limited human and strong animal evidence*
  - *Examples: Methylene Chloride, Styrene, DDT, Nitrogen Mustard*

- **Group 2B**: Possibly carcinogenic in humans (302 agents)
  - *Generally limited human or strong animal evidence*
  - *Examples: Nitromethane, Heptachlor, Disperse Blue 1*

- **Group 3**: Not classifiable (501 agents)
  - *Generally inadequate evidence in humans & limited/inadequate in animals*
  - *Examples: Coffee/Caffeine, Saccharin, Xylene, Isopropyl Alcohol*

- **Group 4**: Evidence of a lack of carcinogenicity in both humans & animals
  - *Only 1 agent (caprolactam 1999)*

504 Agents vs. 502 Agents
Despite at least some self-selection for carcinogens
The Role of Occupational Studies, *cont’d*

- Approximately 2/3 of IARC agents evaluated relate to Occupational or Semi-Occupational Exposures.

- Occupational Exposures Typically Entail:
  - Higher exposure frequency
  - Higher exposure levels
  - Exposed populations easy to identify
  - Exposures easy to measure
  - Healthy adults typically
  - Inhalation is the usual exposure route
The Role of Occupational Studies, cont’d

**Occupational Studies Valuable Because:**

- Most known/suspect carcinogens are found in the workplace.
- Past studies have played a key role in our understanding of cancer.
  - Good exposure records in industry
  - Well defined populations; easily tracked and followed
  - Higher exposure levels and frequencies
  - Single or a couple agents involved
- Occupational carcinogens may have a broad impact beyond the workplace:
  - Can be released into the environment
  - Present in food, water, and pharmaceuticals
  - Present in consumer goods
  - Take-home toxics
The Role of Occupational Studies, *cont’d*

- Approximately 1/3 of IARC agents evaluated relate to Environmental or General Population Exposures.

- Environmental Exposures Typically:
  - Less frequent exposures
  - Lower exposure levels
  - Challenging to identify exposed population
  - Challenging to measure exposures
  - General populations – elderly, young, varied health status
  - Multiple exposure routes – inhalation, ingestion, skin contact, etc.
The Role of Occupational Studies, *cont’d*

**Environmental Studies Valuable For:**

- Unique exposures not usually found in the workplace
  - Second hand tobacco smoke
  - Erionite

- Susceptible population at risk is outside the workplace
  - Very old or young
  - Genetically predisposed populations
  - Population susceptible due to illness, social disparity, or other conditions

- Relative risks are small and only large exposed populations provide adequate statistical power to discern an effect.

- Circumstances when occupational studies are not possible.
The Role of Occupational Studies, cont’d

Author’s Conclusions:

• Both Occupational and Environmental Studies have applications to industrial hygiene depending on the agent, circumstances, populations, etc.

• Occupational Studies were more common in the past by a factor of 2:1

• Occupational Studies becoming less common now
  – Employers can be unwilling to allow investigators access to a plant
  – Fear of liability and potentially admitting wrong-doing
  – Decline of a sense of the “social contract” and working for the common good
  – Decline in union representation in the workplace

• Environmental and population studies may now assume a greater role in providing information about carcinogens
The Role of Occupational Studies, conclusion

Discussion? Questions?
Estimating Personal Exposures with a Multi-Hazard Sensor Network

- Personal monitoring has been preferred since 1960’s for evaluating occupational exposures. But...
- Personal monitoring can have disadvantages:
  - Expense
  - Labor intensive; and now fewer dedicated IH professionals/departments
  - Burdensome to workers (maybe...)
  - Potentially low sample size (result of first two factors?)
- Area Sampling *may* help to address shortfalls by combining:
  - Hazard maps from a wireless sensor network (WSN)
  - Worker location information
  - Continuous real-time monitoring using *relatively low cost sensors*
  - One data point every 5 minutes
  - More robust sample size
  - Ability to better evaluate peak, ceiling, and short-term exposures
Estimating Personal Exposures – The Hardware

The Workplace
• Heavy vehicle manufacturing facility (~800,000 sq. feet (?))
• Cutting, welding, machining, grinding and abrasive blasting
• Low Ceilings
  – Sound Reflective Surfaces? Reverberant Environment?
  – Airflow/Dilution Ventilation Possibly Constrained?

Spatially Optimized 40 Node WSN (Area Monitoring)
• Particulate Matter (PM – Sharps GP dust sensor)
• Carbon Monoxide (Alphasense CO-B4)
• Ozone + NO2 (Alphasense OX-B431)
• Noise (Custom adapted sensor)

Study Staff Wore Direct Reading Instruments (DRI) as a Surrogate for Worker Personal Exposures
Estimating Personal Exposures - Results

• Three Field Campaigns Completed

• 147 to 212 Sets of Estimates Derived from the WSN

• DRI Result Ranges:
  – PM, 0.110 to 0.990 mg/m³ (ACGIH TLV – 3 mg/m³ Resp.; 10 mg/m³ Inhal.)
  – CO, 2 to 17 ppm (ACGIH TLV-TWA – 25 ppm)
  – Ozone, 0 to 57 ppb (ACGIH TLV-TWA “Heavy Work” – 50 ppb)
  – Noise, 71 to 89 dbA (OSHA PEL – 90 dbA; ACGIH TLV – 85dbA)

• WSN (area) results were compared to DRI (personal) results to determine correlation between the two...
Estimating Personal Exposures - Conclusions

WSN Measurements that were within 50% of the DRI Measurements:
- Noise (100%)
- CO (90%)
- PM (59%)
- Ozone (0%)

Authors’ Conclusions:

“Our WSN built with low-cost sensors was able to map occupational hazards with a high degree of spatial and temporal resolution.” And...

“Combined with . . . location information, we have demonstrated that WSNs . . . can generate personal estimates of occupational exposures that, for some hazards, compare favorably to personal sampling.”
Estimating Personal Exposures with a Multi-Hazard Sensor Network

Discussion? Questions?
In Closing....

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Any errors or miss-representations in the presentation are solely my own...
“I have learned much from my teachers, more from my colleagues, and the most from my students.”

-Rabbi Chanina in the Talmud