Occupational hygiene challenges to control carcinogenic chemicals in the workplace

PAHO World Day for Safety and Health at Work Meeting
April 28, 2014
Washington D.C.

José Carlos Espino, Industrial Hygienist
Panama
A **carcinogen** is any substance, radionuclide, or radiation that is an agent directly involved in causing cancer. This may be due to the ability to damage the genome or to the disruption of cellular metabolic processes.

Cancer is any disease in which normal cells are damaged and do not undergo programmed cell death as fast as they divide via mitosis. Carcinogens may increase the risk of cancer by altering cellular metabolism or damaging DNA directly in cells, which interferes with biological processes, and induces the uncontrolled, malignant division, ultimately leading to the formation of tumors.
The IARC categorizes agents, mixtures and exposures into five categories:

- **Group 1**: carcinogenic to humans.
- **Group 2A**: probably carcinogenic to humans.
- **Group 2B**: possibly carcinogenic to humans.
- **Group 3**: not classifiable as to carcinogenicity in humans.
- **Group 4**: probably not carcinogenic to humans.

As OH we are mostly concerned with group I, 2A and 2B substances.
Two traditional OH approaches in assessing carcinogenic substances

1. Occupational Exposure Limit (OEL) approach
2. No OEL approach
Two traditional OH approaches in assessing carcinogenic substances

- Most Occupational Hygienists follow the OEL approach to assess carcinogenic substances, mainly because many carcinogenic substances exist in the environment in trace amounts (i.e. asbestos, benzene, etc.).

- Occupational exposure limit values (OEL) are standards developed as guidelines to assist in the control of health hazards and used by occupational hygienists in making decisions regarding safe levels of exposure to various chemical and physical agents found in the workplace when establishing control measures.

- Because of the complexity of assessing mixtures, governments and organizations have tended to focus on individual chemical substances when developing OEL’s and strategies to prevent harmful exposures to workers health in the use of chemicals at work.
Traditional Occupational Hygiene Process
Strategy for the management of chemicals in the workplace

ILO, 2014
To control exposures to carcinogenic substances we need to:

Understand the exposure profile
Source: Courtesy of Prof. M. Guillemin. Institut universitaire romand de Santé au Travail, Lausanne, Switzerland (slightly modified).
Purpose of Exposure Assessment

It the exposure profile acceptable?
Facts

- OEL commonly establish a time weighted average exposure level that is expected to prevent most health effects from occurring in workers exposed full-time to a chemical. Few long term OEL’s are available.

- Governments or organizations have created lists of recommended occupational exposure limits for several hundred chemicals, it has become clear that the resources to keep these lists up to date are significant. Thus many of these lists contain outdated OELs, that don’t reflect the latest data on the chemical, that are no longer made, or are used so infrequently that few workers are exposed to them.

- Usually not all routes of exposures are accounted for:
  - Inhalation
  - Dermal
  - Ingestion
Challenges regarding the assessment of carcinogenic substances in the L.A. region

Main question: Do we do a good job of assessing occupational exposures?

1. Is the OEL basis understood?
2. What strategy are OH’s following (AIHA, NIOSH, etc.)?
   Answer: strategies are not standardized
2. How many make exposure assessment judgments on fewer than 6 samples on a regular basis?
   Answer: the majority of assessment judgments are made with fewer than 6 samples.
2. How many apply statistics to exposure measurements on a regular basis? And report the results?
   Answer: statistics are usually not applied to analyze the data.
Is the OEL basis understood?

- OEL – definition: It is an acceptable exposure profile defined by the OEL’s sponsoring organization.

- It should clearly stated whether:
  - The OEL is interpreted as a long-term average (i.e., arithmetic mean of the distribution of daily average exposures);
  - A permissible exceedance of day-to-day exposures (e.g., 5%); or
  - A never-to-be-exceeded maximum daily average (e.g., 100% of the daily average exposures are less than the OEL).
Do OEL´s apply to the region?
What strategy are OH´s following (AIHA, NIOSH, etc.)?
How many make exposure assessment judgments on fewer than 6 samples on a regular basis?
How many apply statistics to exposure measurements on a regular basis?

![Log-normal Distribution](image)
How many apply statistics to exposure measurements on a regular basis?

Sample Size Estimation

<table>
<thead>
<tr>
<th>Ratio: true mean/OEL</th>
<th>Low variability (GSD=1.5)</th>
<th>Moderate variability (GSD = 2.5)</th>
<th>High variability (GSD = 3.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>25</td>
<td>82</td>
<td>266</td>
</tr>
<tr>
<td>0.50</td>
<td>7</td>
<td>21</td>
<td>67</td>
</tr>
<tr>
<td>0.25</td>
<td>3</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>0.10</td>
<td>2</td>
<td>6</td>
<td>21</td>
</tr>
</tbody>
</table>

Approximate Sample Size Requirements to be 95% Confident that the True Mean Exposure Is Less Than the Long-term Occupational Exposure Limit
The COLASEH approach for carcinogenic substance exposure assessment:

- **Applying Statistics**
  - Log Normal Distributions
  - Mean vs. Upper Tail?
  - 95% confident below 95%tile estimate

- **Uncertainty**
  - Uncertainty in measurement
  - Uncertainty in OELS

*Statistics should aid judgment not make the judgment*
The COLASEH approach for carcinogenic substance exposure assessment:

Sample 95th Percentile Exposure

- The focus is on the upper tail of the exposure profile.
- The sample 95th percentile can be considered a “compliance statistic”.
- The (usual) goal is to determine which category the 95th percentile most likely falls.
- It is used to assist in reaching a decision that the exposure profile is
  - “Controlled” or “Acceptable”
  - “Unacceptable”
  - ...or falls in a “Control Category”
## The AIHA Model for carcinogenic substances

<table>
<thead>
<tr>
<th>Exposure Control Ratings *</th>
<th>Cutoff (%OEL)</th>
<th>Confidence level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$X_{0.95} \leq 10%$</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>$10% &lt; X_{0.95} \leq 50%$</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>$50% &lt; X_{0.95} \leq 100%$</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>$X_{0.95} &gt; 100%$</td>
<td></td>
</tr>
</tbody>
</table>
$gm = 1.06 \text{ mg/m}^3$
$gsd = 1.83$

point estimate of the 95th percentile
The challenge of OH in Latin America

1. Few OH standards
2. Few OH’s
3. Lack of enforcement
4. Few labs in the region
5. Focus on compliance
¡Attention!
This presentation is copyleft...you can use it, copy it, email it, share it, blog it, twit it, put on facebook or slide share, etc...I only request that you mention the author 😊
The purest form of insanity is to leave everything the same and the same time hope that things will change.

Albert Einstein

Questions?
José Carlos Espino
jose.espino@itsconsultores.net
www.grupo-its.com

Phone: (507)221-2253; (507) 6678-3353