Development of a Risk Prioritization Framework to Evaluate Consumer Cleaning Product Chemical Ingredients

Michael Benjamin, Andrew Maier.

Department of Environmental Health, University of Cincinnati.

University of Cincinnati Education and Research Center

UNIVERSITY OF Cincinnati

Introduction

- Associations have been reported between cleaning agent use and asthma in cleaners and hospital workers[1,2]
- Home healthcare workers perform similar tasks, but in residential environments, which have lower ventilation rates than hospitals and long-term care facilities.[3]
- Wide range of cleaning agents used makes it difficult to prioritize which chemical ingredients pose the greatest risk to users and warrant further study
- AIHA Exposure Control Categories may be used in ranking potential exposures under the same set of conditions[4]

Table 1. AIHA Exposure Control Rating Categories[4]

Exposure Category	Applicable Management/Controls
0 (<1% of OEL)	No special action necessary
1 (1-10% of OEL)	Standard training, general hazard communication
2 (10-50% of OEL)	Chemical hazard communication, periodic exposure monitoring
3 (50-100% of OEL)	Required exposure monitoring, verify work practice controls
4+ (>100% of OEL)	Add hierarchy for controls, monitor effectiveness of controls

Objective

To prioritize cleaning product chemical ingredients by comparing hazard ratios (HR), which are calculated as realistic, worst-case predicted air concentrations (PACs) divided by occupational exposure limits (OELs).

Methods

Collection of Ingredient Information:

- Inventory of two local stores produced a list of 108 cleaning product sprays
- Safety Data Sheets (SDSs) were collected by visiting the manufacturer's website or emailing the company
- Ingredient information was compiled, with the highest ingredient concentration used for calculations.

Defining Realistic Worst-Case Conditions

- Ingredient concentration was determined as highest % in the range given or as 1% default value if "no hazardous chemical in excess of 1%" statement was present on SDS
- Application mass= 15 grams,[5] Volume of small room= 10 m^3, no ventilation, 15 minute exposure
- OEL is the lowest STEL or 8-hour TWA from ACGIH, NIOSH, or OSHA. Chemicals with a TWA but no STEL had a surrogate STEL calculated as 3*TWA.[6]

Calculation of Predicted Air Concentration:

1) Mass in air = 15 grams * (% mass concentration)
2) Air Concentration= Mass in Air/Room Volume (10 m^3)
3) PAC (ppm)= PAC (mg/m^3) * (24.45/Molecular Weight)
4) STEL HR = PAC/STEL
   TWA HR= (PAC * 15/480)/TWA

Results

- ~20% of products did not have SDSs available
- ~20% of products had an SDS, but no chemicals listed under Section 3 (Statement: No Hazardous Ingredients Above 1%)
- Remaining 60% of products with volatile ingredients had hazard ratios calculated, with examples in Table 2 below:

Table 2. Hazard Ratios for Consumer Cleaning Product Ingredients

Chemical	% by Mass	STEL Hazard Ratio	AIHA Rating	TWA Hazard Ratio	AIHA Rating
2-butoxyethanol	10%[B]	2.10*	4	0.19	2
Ethanolamine	1%[A]	1.00	4	0.063	1
Ammonia	1%[A]	0.62	3	0.027	1
Ethanol	75%[B]	0.60	3	0.019	1
Acetic Acid	1%[A]	0.41	2	0.019	1
Diethylene Glycol Monobutyl Ether	5%[B]	0.37*	2	0.035	1
2-propanol	5%[B]	0.076	1	0.005	0
Methanol	1%[A]	0.046	1	0.002	0

*Surrogate STEL calculated as 3*TWA

Limitations

- Can't be used to evaluate ingredients that are nonvolatile (NaOH, Oxalic Acid) or depend on chemical reactions for generation/decomposition (bleach/chlorine, H_2O_2)

Conclusions

- Consumer cleaning products contain volatile irritant chemicals that can produce air concentrations of concern.
- Using AIHA's Exposure Category Framework, ingredients can be ranked by Hazard Ratio under similar conditions, prioritizing chemicals that warrant further study.
- High HRs were typically due to low OELs, except for ethanol, where the HR was due to high % concentration.

References

[1]Lemiere C, Ameille J, Boschetto P, Labrecque M, Pralong JA. Occupational asthma: new deleterious agents at the workplace. *Clin Chest Med.* 2012;33:519-30.

[2]Arif AA, Delclos GL. Association between cleaning-related chemicals and work-related asthma and asthma symptoms among healthcare professionals. *Occup Environ Med*. 2012;69:35-40.

[3]Hittle B, Agbonifo N, Suarez R, Davis KG, Ballard T. Complexity of occupational exposures for home health-care workers: nurses vs. home health aides. *Journal of Nursing Management.* 2016;24:1071–1079.

[4]Jahn SD, Bullock WH, Ignacio JS. A Strategy for Assessing and Managing Occupational Exposures, 4th Edition. American Industrial Hygiene Association (AIHA): Falls Church, VA, 2015.

[5]Park JY, Lim M, Yang W, Lee K (2017) *Exposure factors for cleaning, automotive care, and surface protection products for exposure assessments.* Food and Chemical Toxicology 99:128-134.

[6]ACGIH. TLV Chemical Substances Introduction. http://www.acgih.org/tlv-bei-guidelines/tlv-chemical-substances-introduction, accessed 1/30/2018.

Acknowledgements

This research study was supported by the National Institute for Occupational Safety and Health Targeted Research Training Program of the University of Cincinnati Education and Research Center Grant #T42/OH008432-11

University of Cincinnati
19th Annual
Pilot Research Project
Symposium
October 11-12, 2018

Pilot Research Training Program (PRP) Overview

Welcome to the University of Cincinnati Education and Research Center's (ERC) 19th Annual Pilot Research Project (PRP) Symposium on October 11-12, 2018, held in the Kowalewski Hall Auditorium. The purpose of the PRP is to increase the research capacity of research trainees and young investigators in occupational health and safety and to encourage those in related disciplines to pursue occupational health and safety research.

Under the administrative direction of Dr. Amit Bhattacharya and Dr. Gordon Gillespie, research proposals are solicited and peer-reviewed annually by qualifying faculty and graduate students from the University of Cincinnati and the following PRP partnering institutions – Air Force Institute of Technology, Bowling Green State University, University of Toledo – Health Science Campus, Central State University, Purdue University, University of Kentucky, Western Kentucky University, Eastern Kentucky University, Murray State University, Ohio University and Kentucky State University.

At this symposium, the 2017-18 awardees will be presenting the results of their research and the 2018-19 awardees will make poster presentations of their proposed work. The keynote speaker on Thursday, October 11, 2018 is Captain Lauralynn McKernan from the CDC/NIOSH Division of Surveillance, Hazard Evaluation and Field Studies, presenting on "Listen to the Music: How Rock 'n' Roll Provides Touchstones for the Evolution of Occupational Health."

The University of Cincinnati's Education and Research Center is one of 18 national centers funded by the National Institute for Occupational Safety and Health (NIOSH). Dr. Tiina Reponen serves as the director of the ERC, which is based in the University's Department of Environmental Health within the College of Medicine. The purpose of the ERC is to train professionals in the didactic and research skills necessary to lead in occupational safety and health disciplines. Results of research are translated into action through an outreach program and shared with professionals and practitioners in the region via continuing education.

Since 1999, the PRP program has allocated over $1.4 million to support 239 pilot research projects. These projects have served as a catalyst in bringing over $41 million in additional research support to the region from sources independent of the PRP program, such as, the National Institute for Occupational Safety and Health (NIOSH), National Institutes of Health (NIH), United States Department of Agriculture (USDA), National Science Foundation (NSF), and the Centers for Disease Control and Prevention (CDC). Additionally, the PRP has brought 55 new investigators from other fields of expertise to the area of occupational safety and health research.

Return to Main Menu

University of Cincinnati
19th Annual
Pilot Research Project
Symposium
October 11-12, 2018

Hosted by: The University of Cincinnati Education and Research Center
Supported by: The National Institute for Occupational Safety and Health. (NIOSH) Grant #: T42-OH008432

Main Menu: