Clear and preventable danger? A Haddon matrix safety analysis of student injuries sustained in a university's chemistry laboratories

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Background

Recent media reports have highlighted the potential danger of working in an academic chemistry laboratory, most memorably with the deaths of 2 students at UCLA and Yale. Our Toxicology service has noted a recent increase of ED patients presenting after laboratory-related incidents.

Hypothesis

A Haddon matrix is a paradigm commonly used in public health. This tool may reveal potential areas of vulnerability and may be especially helpful in evaluating laboratory practices in academic laboratories.

Methods

From medical toxicology service logs (1/1/2008-10/3/2013), cases were collected that met these inclusion criteria: (1) Had inadvertent exposure to a chemical hazard, (2) Presented to the ED, (3) Was seen by a medical toxicologist as a consultation (Figure 1).
Data relating to the chemical, route, symptoms, safety equipment, personal protective equipment (PPE), and prearrival decontamination were collected. The data was organized in a Haddon matrix where pre-exposure, exposure and post-exposure factors relating to the host, agent and environment (Figure 2). After review, this study was IRB exempt.

Results

Figure 1. Five cases of accidental lab exposure.

Chemical	Route	Symptoms	Equipment	PPE	Prearrival decontamination
Dicobalt octacarbonyl	Inhalational	Chest fullness	Glovebox	Gloves	None
Hydrofluoric acid (45%)	Inhalational	Chest pain, shortness of breath, throat irritation	Chemical hood	None	None
Cyanide salts	Ingestion	Chest pain, shortness of breath	None	None	None
Phenol	Dermal	Skin discoloration, irritation	None	None	Soapy water x 2 minutes, then regular water x 10 minutes
(1) 4-nitrophenyl chloroformate (2) Acetonitrile	Ocular	Red eyes	None	None	5 minute rinse

Discussion

Figure 2. Haddon matrix analysis of laboratory near-misses.

Phase	Host	Agent	Environment
Pre-exposure	• Inadequate safety education • Inadequate awareness of risk • Decreased vigilance	• Improper storage • Chemical volatility	• Contaminated work area • Emphasis on productivity Lax employment screening
Exposure	• Unaware exposure • Prolonged exposure • Unfamiliar chemical properties • Incomplete adherence to safety measures	• Corrosivity • Hazardous chemical • Duration of exposure	• Nonfunctioning equipment and improper use of functioning equipment • No "buddy system" • Lack of PPE
Post-exposure	• Not seeking medical attention • Inadequate decontamination • Fear of retaliation if reported	• Potential of agent to cause delayed reaction or injury	• Improper spill containment → future exposure risk • No oversight to monitor injury

Conclusion

Despite increased awareness of lab safety and more rigorous safety protocols, incidents of inappropriate and potentially dangerous exposures are still occurring. There are still ample opportunities to reduce risk to our students and lab personnel as revealed by our multi-factorial analysis.

Future Implications

Sharing the information obtained by the Haddon matrix analysis with the safety office is our next step. Safety training seems inadequate, and each student should understand and identify the hazardous risks and properties of chemicals that they use in their research and near their workspace. We hope to extend this study to other sites as well.