# How First Responders Use Decision-Support Tools during Chemical Emergencies: The Nexus of Culture, Context, and Cognition

**Suresh K. Bhavnani[1] PhD, Bryant Dang[1] BS, Kai Zheng[2] PhD, Chris Weber[3] PhD**
[1]Institute for Translational Sciences, University of Texas Medical Branch, Galveston, TX;
[2]School of Public Health, University of Michigan; [5]Dr. Hazmat Inc., Denver, CO

## Abstract

*Although first responders use a wide range of decision-support tools to identify toxic chemicals during emergencies, few studies have analyzed the tasks and contexts in which such tools are used. Here we discuss an in-depth analysis of semi-structured interviews conducted with 20 first responders from two US states. In the first phase of the analysis, we identified three intersecting themes related to the plurality of roles played by first responders, the combination of tools used, and the range of triggers leading to the use of decision-support tools. In the second phase of the analysis, an additional expert first responder through a series of interviews interpreted the results as emanating from a complex interplay of economic factors, and the trade-off between personal risk versus potential harm to victims and the environment. This emergent grounded theory provides insights into the cultural, contextual, and cognitive differences between decision-support tools used by first responders versus those used by clinicians, with implications for the design of more effective tools for first responders.*

## Introduction

Identification of toxic chemicals during emergencies is a complex and stressful task that uses a wide range of decision-support tools (e.g., WISER[1]), resulting in critical decisions related to rescue, containment, and cleanup. Unfortunately, while there exist numerous prescriptions and policies for conducting such operations, few studies have probed the tasks and contexts in which such tools are used.

## Method and Results

Given the practical difficulties of directly observing toxic chemical incidents, we conducted semi-structured interviews with first responders experienced in identifying toxic chemicals during chemical emergencies. Using a snowball method, we recruited 20 first responders from fire departments, emergency management teams in hospitals, and chemical plants across two US states. The participants were asked to describe their role as first responders, and the context, tasks, and tools they used during a chemical incident which was potentially hazardous to humans. The interviews were audio-recorded, transcribed into 274 pages of text, and subsequently analyzed in two phases using the grounded theory approach.[2]

In the first phase of the analysis we identified three intersecting themes: (1) First responders played **multiple roles** during an incident. For example, a responder played three different roles including scene response, chemical assessment, and hazmat training, out of a total of 11 different roles identified across all participants. (2) First responders used a **combination of tools** to identify the chemicals in an incident. For example, an incident related to identifying a suspicious chemical in an abandoned truck required the use of a combustible gas indicator, a pH meter, and tools in a lab to assist human judgment in determining the nature of the liquid. (3) First responders encounter **multiple triggers** to use decision-support tools including the absence of a sample or Hazmat id, and suspected errors or absence of a reading from meters.

In the second phase of the analysis, we conducted 3 interviews with an additional expert first responder where we presented the above themes with the goal of verifying and deepening our understanding of the results. These interviews revealed two overarching explanations for the emergent themes: (1) Hazmat teams that have smaller budgets can afford fewer instruments which detect and/or identify chemicals, and therefore possibly rely more heavily on decision-support tools such as WISER. Such teams also tend to play more roles compared to teams with larger budgets that have more specialists. (2) Some Hazmat teams minimize risk to their first responders by collecting substantial information from different decision-support tools before entering a hot zone with an unknown chemical; others make calculated risks based on the potential harm the delay could cause to victims and the environment. The triggers for tool use are therefore contingent on the outcomes of such trade-offs. This emergent grounded theory therefore provides a nuanced understanding of how culture, context, and cognition mediate behavior during an emergency incident. The team economics, and risk trade-offs explain the critical dimensions by which decision-support tools for emergency response are different from those used by clinicians, and provide implications for the development of decision-support tools that are targeted to different types of team sizes and decision-making processes, with the goal of enabling more effective responses during emergencies.

## References

1. Bhavnani, S.K., et al. Network Analysis of Toxic Chemicals and Symptoms: Implications for Designing First-Responder Systems. *Proc. of AMIA'07* (2007).
2. Glaser BG, Strauss AL. *The Discovery of Grounded Theory*. New York: A. de Gruyter; 1967.