Toxic Industrial Chemicals and Chemical Weapons

Exposure, Identification, and Management by Syndrome

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KEYWORDS

• Toxidrome • Toxic industrial chemicals • Exposure history • Antidotes

KEY POINTS

- Causes of medical conditions resulting from chemical exposures may be elusive unless an exposure history is taken during the medical interview.
- Clinicians should address elements of the exposure history, using a systematic approach to improve the diagnostic accuracy of that history.
- Recognition of common toxidromes may facilitate diagnosis and treatment of patients exposed to unknown toxic chemicals.
- Understanding basic principles of toxicology and the significance of exposure limits can aid in the evaluation of exposed patients.
- Use of specific antidotes may rescue patients with specific exposures; therefore, clinicians should advocate for the availability of these agents.
- Clinicians should become familiar with the available resources for chemical exposures.

INTRODUCTION

With approximately 100,000 chemicals used each day in US industry, the range of hazardous materials situations that may challenge emergency care providers is daunting. Moreover, many of these chemicals have never been tested for safety with respect to environmental effects or human exposure.[1] Despite and because of technological advances, chemical spills and disasters will continue to occur, and these exposures

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may impact individuals or large populations. Although progress has been made in the use of "green chemistry," safer manufacturing processes, increasing use of personal protective equipment (PPE), and engineering controls, many of the chemicals in common use are potentially injurious. Increasing population density, settlement of high-risk areas, increasing dependence on industrial chemicals, human errors, and terrorism are among the many factors that cause disasters.[2] The expansion of terrorism coupled with the potential deployment of expedient chemical weapons makes it clear that emergency care providers must be prepared to handle exposures resulting from toxic industrial materials.

Although chemical exposures resulting from spills, terrorist attacks, and other dramatic events may result in immediate recognition, other less obvious or intentionally covert exposures may go unrecognized. This is especially true given the pace of today's emergency departments and medical offices.[3] It is important for emergency and primary care providers to document exposures and work-related conditions and to recognize opportunities for preventive care. Best practices may be facilitated by charting prompts and use of an exposure history form.[4]

The impact that even a brief exposure history may have on a patient's quality of life is illustrated by the following case. An exposure history taken by one of the authors (AJT) for a young adult construction worker without history of asthma who presented for care of bronchospasm revealed that he had recently begun using isocyanate-containing insulating materials. This use resulted in isocyanate sensitization, presumed isocyanate antibody production, and resultant asthma. The case was referred to occupational medicine and the presence of antibodies to isocyanate was confirmed. Identification of the cause of the patient's bronchospasm resulted in termination of isocyanate exposure with resultant improvement in his bronchospasm.[5] Chemical awareness, a high index of suspicion, an exposure history, and good follow through are essential for quality care of the patient with a possible chemical exposure.

It is useful for providers to think of exposures in terms of the acuity and urgency of the medical sequelae. Some exposures (eg, exposure to a high concentration of chlorine gas) may result in immediate effects (respiratory irritation and dyspnea secondary to lung injury and adult respiratory distress syndrome), whereas other exposures may result in short-term, delayed effects (exposure to a lesser concentration of chlorine may produce delayed pulmonary edema up to a day after exposure). Still other exposures may not be apparent for years, such as chemical carcinogenesis caused by benzene resulting in acute myelogenous leukemia. An understanding of the toxicologic principles of dose, route of exposure, and mechanism of toxicity combined with individual patient factors can aid in the establishment of a diagnosis and help with decision-making.

LESSONS LEARNED FROM PREVIOUS CHEMICAL DISASTERS

In addition to the immediate health, environmental, and economic effects of chemical releases, exposures may have severe long-term consequences. For example, on December 2–3, 1984, methyl isocyanate and other chemicals were released from a storage tank at a Union Carbide India plant that manufactured the carbamate insecticide carbaryl in Bhopal, India. This may qualify as the world's worst toxicologic disaster. More than 500,000 individuals were exposed in the impoverished towns surrounding the plant, and 3787 deaths were reported by the regional government.[6–9] Adult respiratory distress syndrome was the likely cause of death in most acute cases, with many deaths likely resulting from secondary respiratory infections. An increased