StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-.

Hydrocarbon Inhalation

Kristin W. Brown; Tyler J. Armstrong.

Author Information and Affiliations

Last Update: April 7, 2023.

Continuing Education Activity

Hydrocarbons are organic compounds that consist of hydrogen and carbon. They are ubiquitous in society and are present in many common household and occupational products, including motor fuels, paint thinners, cleaning agents, lotions, and industrial solvents. Unfortunately, these products are also used as agents of abuse and typically inhaled. Serious toxicity and death can be associated with hydrocarbon exposure. Pulmonary toxicity is most common, however the cardiovascular system, nervous system, and gastrointestinal system can all be affected. This activity reviews the evaluation and management of hydrocarbon toxicity and highlights the role of the interprofessional team in the management of affected patients.

Objectives:

- Explain the pathophysiology of hydrocarbon toxicity.
- Describe the signs and symptoms of hydrocarbon toxicity.
- Summarize the treatment options available for hydrocarbon toxicity.
- Explain interprofessional team strategies to improve care coordination and communication to advance the diagnosis and management of hydrocarbon toxicity and improve outcomes.

Access free multiple choice questions on this topic.

Introduction

Hydrocarbons are organic compounds that consist of hydrogen and carbon. They are quite ubiquitous in society and are present in many common household and occupational products, for example, in motor fuel, paint thinner, cleaning agents, lotion, and industrial solvents. Unfortunately, these products are also used as agents of abuse and typically are inhaled for their euphoric effects. Inhalation is made possible by the volatility of these substances.[1]

Serious toxicity and death can be associated with hydrocarbon exposure through inhalation, ingestion, or aspiration. Pulmonary toxicity is most common, however cardiovascular, nervous, and gastrointestinal systems can all be affected.

Etiology

Hydrocarbons are a primary energy source in modern society. They are derived mainly from petroleum (kerosene, gas, naphtha) or wood (turpentine, pine oil). They can be found in liquid, gas, or solid form depending on their properties. All hydrocarbons can be toxic, but aromatic (ring-shaped) and halogenated hydrocarbons typically have more severe toxicity.

Toxicity occurs in various ways including through inhalation, ingestion, aspiration, and dermal exposure. Frequently, these exposures occur during attempted recreational use of the substances and sometimes for self-injurious behavior. Three inhalation methods for recreational uses are common. These include “huffing” or breathing through a rag soaked with the inhalant, “bagging,” which means repeatedly inhaling deeply from a bag filled with the hydrocarbon, and “sniffing” or directly inhaling the hydrocarbon through the nostrils. Most commonly abused hydrocarbons are paints, solvents, and gasoline.[2]

Epidemiology

Hydrocarbon toxicity affects more than 30,000 Americans per year. Approximately 20 deaths per year are attributed to hydrocarbon toxicity. Children younger than five years old as well as adolescents are disproportionately affected. Abuse is becoming increasingly common with an estimated 20% of middle and high school students reported having tried these volatile substances. The most common complications are pneumonitis followed by central nervous system and cardiovascular effects.[3][2][4][5]

Pathophysiology

Multiple factors determine the toxicity of hydrocarbons. These include physical and chemical characteristics, dose and concentration, additives, and routes of exposure. Aspiration risk is directly related to the physical characteristics such as viscosity, surface tension, and volatility. Viscosity is a measurement of the resistance to flow, surface tension refers to the ability of particles to cohere together, and volatility is the tendency for a liquid to change to gas. Lower viscosity, lower surface tension, and higher volatility all increase the risk of aspiration and subsequently, increase the risk of toxicity. These specific properties allow for easy flow, diffuse spread on mucosa and lung surfaces, and ability to vaporize at body temperature, respectively. Inhalation or ingestion can both allow for easy absorption of the hydrocarbon which can lead to systemic toxicity.[6]

The pulmonary system is most commonly affected by inhalation or aspiration. Depending on the specific substance's characteristics or significant systemic absorption, multiple systems in the body may be affected by these same routes of exposure. Pulmonary toxicity from inhalation or aspiration occurs from direct toxicity. Hydrocarbon pneumonitis is caused by the destruction of alveolar and capillary membranes as well as alteration of surfactant function and production. This eventually can lead to ARDS due to increased vascular permeability and edema. Progression to necrotizing pneumonitis and hemorrhagic pulmonary edema is ultimately possible. Rarer pulmonary complications include lung necrosis, pneumothorax, pneumatocele, or bronchopleural fistula. Ultimately, hypoxia develops secondary to ventilation/perfusion mismatch, shunt formation, and direct displacement of alveolar oxygen.[7][8]

Cardiac toxicity is also a possibility following hydrocarbon exposure. Life-threatening dysrhythmias may occur such as ventricular tachycardia or fibrillation. “Sudden sniffing death syndrome” has been described in hydrocarbon abusers which occurs shortly after exposure often without any preceding symptoms. This typically occurs after a patient is “excited” while they are huffing or bagging leading to a large surge of catecholamines. This large surge of catecholamines, although typically not an issue, causes risk of arrhythmias due to increased myocardium sensitization, a side effect of hydrocarbons.[9][10]

The primary CNS effect associated with hydrocarbon toxicity is a decreased level of consciousness. Multiple pathways ultimately lead to this decreased level of consciousness. Many

hydrocarbons cross the blood-brain barrier causing direct toxicity. There are also indirect CNS effects as a result of severe hypoxia from lung injury or oxygen displacement or hypercarbia from the act of rebreathing into a bag. Prolonged and recurrent exposure to hydrocarbons can lead to white matter degeneration as well as peripheral demyelination.[1]

Other systems are also commonly affected. Hydrocarbons are gastrointestinal (GI) irritants which lead to burning abdominal pain, vomiting or even gastric perforation; however, this is more common with ingestion as opposed to inhalation. Hepatic damage, especially from chlorinated hydrocarbons, is not uncommon and appears to have a similar course as that of acetaminophen hepatotoxicity. Toluene, an aromatic hydrocarbon, has a propensity to cause renal tubular acidosis or severe hypokalemia, similar to hypokalemic periodic paralysis. Some specific hydrocarbons also are associated with hematologic disorders, including benzene and naphthalene. Methemoglobinemia and delayed carboxyhemoglobinemia are specifically associated with exposure to hydrocarbons containing amines and methylene chloride, respectively. Rashes may be noted over the face or on the hands of habitual inhalation users secondary to irritation or sensitization. Dermatitis, cellulitis, and soft tissue necrosis are also possible depending on the method of exposure.[11][12][13]][14]

History and Physical

Patients with acute hydrocarbon-related illness most often present with respiratory complaints. Symptoms usually occur within 30 minutes of exposure but may be delayed for hours. Patients will typically present with coughing, choking, or vomiting with aspiration. They may have findings of hypoxia and increased work of breathing. Initial neurologic symptoms may be agitation, hallucinations, tremors, but generally, hydrocarbons are neurologic depressants. Patients also may have GI complaints such as a burning sensation or nausea with frequent vomiting. In patients with prolonged exposure, patients may complain of rashes, chronic headaches, peripheral neuropathy, or cognitive impairment.

Evaluation

All patients presenting with suspicion or symptoms of hydrocarbon exposure should immediately be placed on a cardiac monitor as well pulse oximetry. There are no specific quantitative tests for hydrocarbons, but identification of the specific hydrocarbon substance may help guide management and anticipate adverse events. A chest radiograph is indicated in any patient suspected of inhalation or aspiration of hydrocarbons. However, initial imaging may be normal despite a patient displaying symptoms. Alternatively, initially asymptomatic patients may have abnormal radiographs later during their course. About 6 hours after exposure, patients will experience symptoms or have changes in pulse oximetry or chest radiography. ECG is indicated as well as a basic metabolic profile, hepatic function tests, and a complete blood count. Carboxyhemoglobin or methemoglobin levels may also be helpful if there is a concern for exposure to specific hydrocarbons mentioned previously.

Treatment / Management

Supportive care is the mainstay of treatment, beginning with control of airway, breathing, and circulation. Securing the airway or administering supplemental oxygen is often required in cases of significant exposure. Depending on the amount of pulmonary edema, positive pressure may be necessary to maintain oxygenation. The exogenous surfactant has been used with success; however, steroids and antibiotics are not proven to be beneficial. In the event of hypotension,

aggressive fluid resuscitation is recommended as catecholamines such as epinephrine and norepinephrine may cause dysrhythmias. In the case of hydrocarbon ingestion, gastric lavage or charcoal is not used as these substances are quickly absorbed. Charcoal is contraindicated due to the high risk of aspiration. Decontamination should be done before arriving in treatment areas to decrease the risk of secondary exposure to fumes. Consultation with a toxicologist is recommended, especially in higher-risk exposures such as aromatic or halogenated hydrocarbons.

Patients who are asymptomatic after 6 hours from inhalation or aspiration without any changes on pulse oximetry or chest radiography can be discharged with good return precautions. Hospitalization is required in patients with moderate to severe symptoms or patients with exposures to hydrocarbons that may produce delayed complications such as hepatotoxicity.[15]

Differential Diagnosis

- Acute respiratory distress syndrome
- Alcohol toxicity
- Aspiration
- Barbiturate toxicity
- Benzodiazepine toxicity
- Carbon monoxide poisoning
- Co-ingestions
- Inhalation injury
- Suicidality
- Toluene toxicity

Enhancing Healthcare Team Outcomes

The management of patients with hydrocarbon toxicity is with an interprofessional team that also includes ICU nurses. All patients presenting with suspicion or symptoms of hydrocarbon exposure should immediately be placed on a cardiac monitor as well as pulse oximetry. There are no specific quantitative tests for hydrocarbons, but identification of the specific hydrocarbon substance may help guide management and anticipate adverse events. A chest radiograph is indicated in any patient suspected of inhalation or aspiration of hydrocarbons.

There is no specific treatment for hydrocarbon toxicity, but close monitoring of the cardiovascular and pulmonary organs is highly recommended.

Review Questions

- Access free multiple choice questions on this topic.
- Comment on this article.

References

1. Tormoehlen LM, Tekulve KJ, Nañagas KA. Hydrocarbon toxicity: A review. Clin Toxicol (Phila). 2014 Jun;52(5):479-89. [PubMed: 24911841]
2. Spiller H, Lorenz DJ. Trends in volatile substance abuse. J Addict Dis. 2009;28(2):164-70. [PubMed: 19340679]
3. Burns A, Shin JM, Unice KM, Gaffney SH, Kreider ML, Gelatt RH, Panko JM. Combined analysis of job and task benzene air exposures among workers at four US refinery operations. Toxicol Ind Health. 2017 Mar;33(3):193-210. [PMC free article: PMC5477978] [PubMed: 26862134]
4. Garland EL, Howard MO, Vaughn MG, Perron BE. Volatile substance misuse in the United States. Subst Use Misuse. 2011;46 Suppl 1:8-20. [PubMed: 21609140]
5. Jolliff HA, Fletcher E, Roberts KJ, Baker SD, McKenzie LB. Pediatric hydrocarbon-related injuries in the United States: 2000-2009. Pediatrics. 2013 Jun;131(6):1139-47. [PubMed: 23650296]
6. Ford JB, Sutter ME, Owen KP, Albertson TE. Volatile substance misuse: an updated review of toxicity and treatment. Clin Rev Allergy Immunol. 2014 Feb;46(1):19-33. [PubMed: 23649409]
7. Connellan SJ. Lung diseases associated with hydrocarbon exposure. Respir Med. 2017 May;126:46-51. [PubMed: 28427549]
8. Mallavarapu RK, Katner HP. Pneumatocele complicating acute hydrocarbon pneumonitis. Clin Toxicol (Phila). 2008 Nov;46(9):911. [PubMed: 18792828]
9. Romolo FS, di Luca NM, Ciallella C, Bottoni E, Fiore PA, Cappelletti S, Giuliani N, Augsburger M, Varlet V. Volatile lipophilic substances management in case of fatal sniffing. J Forensic Leg Med. 2017 Nov;52:35-39. [PubMed: 28850861]
10. LoVecchio F, Fulton SE. Ventricular fibrillation following inhalation of Glade Air Freshener. Eur J Emerg Med. 2001 Jun;8(2):153-4. [PubMed: 11436914]
11. Williams PR, Mani A. Benzene Exposures and Risk Potential for Vehicle Mechanics from Gasoline and Petroleum-Derived Products. J Toxicol Environ Health B Crit Rev. 2015;18(7-8):371-99. [PubMed: 26514691]
12. Ungprasert P, Kue-A-Pai P, Permpalung N, Kittanamongkolchai W, Cheungpasitporn W. Toluene-induced renal tubular acidosis: an easily missed cause of hypokalemic paralysis. Am J Emerg Med. 2012 Sep;30(7):1309. [PubMed: 22795428]
13. Dharmarajan L, Ammar H. Expanding the differential: toluene-induced toxicity. BMJ Case Rep. 2017 Aug 01;2017 [PMC free article: PMC5623982] [PubMed: 28765189]
14. Glass DC, Gray CN, Jolley DJ, Gibbons C, Sim MR, Fritschi L, Adams GG, Bisby JA, Manuell R. Leukemia risk associated with low-level benzene exposure. Epidemiology. 2003 Sep;14(5):569-77. [PubMed: 14501272]
15. Seymour FK, Henry JA. Assessment and management of acute poisoning by petroleum products. Hum Exp Toxicol. 2001 Nov;20(11):551-62. [PubMed: 11926609]

Disclosure: Kristin Brown declares no relevant financial relationships with ineligible companies.

Disclosure: Tyler Armstrong declares no relevant financial relationships with ineligible companies.

Bookshelf ID: NBK470289 PMID: 29262161