International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol. 11 No. 5 May-June 2024

The Health Consequences of Household Chemicals

Dasi kavya[1], Syeda Nishat Fathima[2]
[1,2]Department of Pharmacology, Jayamukhi College of Pharmacy, Narsampet, Warangal, Telangana, India
Corresponding Author - Dasi kavya
DOI- 10.5281/zenodo.12754395

Abstract:
Household chemicals can pose serious health risks to infants, as their developing bodies are more vulnerable to toxins. Common household chemicals, such as cleaning agents, pesticides, and air fresheners, can contain harmful ingredients that may lead to respiratory issues, skin irritation, or even long-term health impact. This article examines common household chemicals such as sodium hypochlorite, ammonia, isopropyl alcohol, hydrocarbons and others, detailing their uses and potential health risks.

Keywords: Household chemicals; sodium hypochlorite; isopropyl alcohol; hydrocarbons

Introduction:

Household chemicals are non-food chemicals that are commonly found and used in and around the typical household and are designed particularly to assist cleaning, pest control, and for general hygiene purposes. Various household cleaning products have been developed to help remove dust and dirt, for surface maintenance, and for disinfection. Products are available in powder, liquid or spray form. The basic ingredients determine the type of cleaning tasks for which they are suitable. Some are marketed as general-purpose cleaning materials, while others are targeted at specific cleaning tasks such as drain clearing, oven cleaning, lime scale removal and polishing furniture. Household cleaning products provide aesthetic and hygiene benefits, but may cause health risks. [1] [2]

The common household chemicals are used as:

- floor cleaners, general purpose cleaners, polishing products, carpet cleaners, scale removing products, bathroom cleaners, glass cleaners, disinfection products, kitchen cleaners, and other surfaces cleaners.
- mothballs, crystals, bars, or synthetic closet fresheners,
- antibacterial soap or other antibacterial hand products,
- professional pest control or extermination service products,
- ant, fly, or cockroach control products,
- rat, mouse, gopher, or mole control products,
- insect repellent for ticks or mosquitos,
- slug or snail bait,
- weed control products,
- plant/tree insect or disease control products,
- paint, stains, or lacquers,
- adhesives or petroleum products,
- indoor foggers for insect control,
- sprays, dusts, powders, or skin applications for fleas or ticks, or flea or tick collars.

When multiple chemicals are applied to the same surface without full removal of the earlier substance, the chemicals may interact. This interaction may reduce the efficiency of the chemicals applied (such as a change in pH value caused by mixing alkalis and acids) and in some cases may even emit toxic fumes. An example of this is the mixing of ammonia-based cleaners (or acid-based cleaners) and bleach. This causes the production of chloramines that volatilize (become gaseous), causing acute inflammation of the lungs (toxic pneumonia), long-term respiratory damage, and potential death. Residue from cleaning products and cleaning activity (dusting, vacuuming, sweeping) has been shown to worsen indoor air quality by redistributing particulate matter (dust, dirt, human skin cells, organic matter, animal dander, particles from combustion, fibres from insulation, pollen, and polycyclic aromatic hydrocarbons) to which gaseous or liquid particles can be adsorbed. The concentration of such particulate matter and chemical residual will highest immediately after cleaning, and will decrease over time depending upon levels of contaminants, air exchange rate, and other sources of chemical residual. VOCs, including formaldehyde, toluene, and limonene, are harmful chemicals found in household cleaning products. These vapors can be inhaled, aggravate asthma symptoms, and can be inhaled into the lungs or absorbed by dust. Other modes of exposure to potentially harmful household cleaning chemicals include absorption through the skin (dermis), accidental ingestion, and accidental splashing into the eyes. Products for the application and safe use of the chemicals are also available, such as nylon scrub sponges and rubber gloves. It is up to consumers to keep themselves safe while

using these chemicals. Reading and understanding the labels is important. Chemicals used for cleaning toilets, sinks, and bathtubs can find their way into sewage water and can often not be effectively removed or filtered.

The chemicals that are commonly found in the households are sodium hypochlorite, ammonium hydroxide, isopropyl alcohol, hydrocarbons, borax, Volatile organic compounds etc.,

Sodium hypochlorite:

Sodium hypochlorite is widely used as the main component of cleaners and has an excellent bleaching and sterilizing effect in living and medical environments. In addition to bleaching, it is used for wastewater treatment and for sterilization in food factories, and also for disinfectants. Hypochlorite's potential to cause toxicity is related to its oxidizing capacity and the pH of the solution. Toxicity arises from its corrosive activity upon contact with mucous membranes and skin. Sodium hypochlorite itself may be toxic if ingested, or by dermal or ocular exposure. If mixed with acidic solutions chlorine gas is produced, and mixing with ammonia-based solutions gives rise to chloramine solution, both of which contribute to toxic effects. Ingestion of small volumes of sodium hypochlorite causes burns to the mouth and throat, gastrointestinal irritation, nausea and vomiting. Ingestion of any amount of industrial strength bleach (>10% sodium hypochlorite) or large amounts (approximately 300 mL in adults; 100 mL in children) of household bleach (<10% sodium hypochlorite) may cause abdominal and retrosternal pain and diarrhoea. Aspiration of liquid may lead to pulmonary complications such as acute respiratory distress syndrome (ARDS). Inhalation of chlorine gas causes burning of the throat and lungs, eye and nose irritation, chest tightness and coughing. At higher levels of exposure, tachypnoea, cyanosis and swelling of the airway may occur. Pulmonary oedema and respiratory failure may arise in severe cases, the onset of which may take up to 36 hours. Sodium hypochlorite is corrosive and may irritate the skin or cause burning, pain, inflammation and blisters. Ocular exposure can cause irritation, pain, lacrimation and photophobia. [3]

Ammonia/ Ammonia Hydroxide:

Household 'ammonia' is a solution of NH3 in water, and is used as a general-purpose cleaner for many surfaces. Because ammonia results in a relatively streak-free shine, one of its most common uses is to clean glass, porcelain, and stainless steel. It is also frequently used for cleaning ovens and for soaking items to loosen baked-on grime. Household and industrial cleaners contain anywhere from 5% to 25% of ammonia in dissolved form. Hence the residents, especially children of such households, are at an increased risk for accidental or suicidal ingestion exposure. The spillage of such products can lead to significant inhalational exposure as well. Anhydrous ammonia reacts with water in human tissue to form ammonium ions, causing thermal injury and liquefaction necrosis. Its extraction of water initiates an inflammatory response. Exposure to liquid ammonia, typically stored at -28 degrees F, results in cold-induced thermal injury. Gaseous ammonia can cause corneal injury, skin burns, and respiratory tract injuries. Ingestion can cause injuries along the alimentary canal and perforation of the hollow viscera. There is little evidence to suggest that exposure to external sources of ammonia can lead to hyperammonemia and systemic toxicity, such as hepatic encephalopathy. Overall, ammonia exposure is not a significant risk factor for health. [4]

Isopropyl alcohol:

Isopropanol, or isopropyl alcohol, is a clear, colorless liquid that emits an odor that resembles acetone. It is a commercially available product that mainly is found as a 70% solution in rubbing alcohol and hand sanitizers. Isopropyl alcohol toxicity is often linked to rapid inebriation and hemorrhagic gastritis. Its symptoms include dizziness, headache, and inebriation, as well as abdominal pain, nausea, vomiting, and hematemesis. Physical examinations show isopropanol intoxication mimics ethanol intoxication, with altered sensorium, hypotension, hypothermia, and cardiopulmonary collapse. Miosis is common, and patients may experience loss of reflexes. [5]

Glycol Ether/ Ethylene glycol:

Ethylene glycol is a colorless, odorless, sweet-tasting but poisonous type of alcohol found in many household products. Glycol ether exposure can occur in both household and occupational settings, with cleaners, printing machine operators, semiconductor manufacturing workers, chemical industry workers, automobile mechanics, cosmeticians, secretaries, and printers being most vulnerable. Glycol ethers are rapidly absorbed via dermal, inhalational, and gastrointestinal routes. Ingestion is the least likely mode of exposure but has the greatest potential to cause toxicity. Ethylene glycol ethers, are organic acids metabolized by the liver enzyme alcohol dehydrogenase into toxic alkoxyacetic acids. These organic acids are responsible for Glycol ethers ' renal, neurologic, and reproductive side effects. The most frequently studied Glycol ethers compounds include 2-methoxyethanol, 2-ethoxyethanol, 2-butoxyethanol, 2-propoxyethanol, 2-isopropoxyethanol, and 2-phenoxyethanol. Neurological injury is caused by acute encephalopathy, personality changes, memory loss, headaches, dizziness, ataxia, tremors, and lethargy. in vivo studies show that administering Ethylene glycol ether mixtures to rats' frontal cortex and hippocampus leads to reduced antioxidant capacity, heightened lipid peroxidation, and elevated caspase-3 activity, indicating oxidative stress as the

mechanism of Ethylene glycol ether toxicity. Renal damage is reported following acute Ethylene glycol ether ingestion, with alkoxyacetic acid-induced renal tubular degeneration and necrosis found in autopsies after fatal Ethylene glycol ether poisoning. Hepatic effects of Ethylene glycol ether are predominantly metabolized in the liver, with hepatic injury arising from mitochondrial disruption by Ethylene glycol ether metabolism-derived reactive oxygen species, impairing cellular metabolism, haemolysis, and iron deposition in the liver. Studies also show that diethylene glycol monomethyl ether and ethylene glycol monomethyl increase microsomal protein concentrations and induce hepatic enzymes. Reproductive toxicity and neurodevelopmental disorders are associated with certain Ethylene glycol ethers, with testicular weight changes, oedema, and tubular atrophy. Routine Ethylene glycol ether exposure has been shown to reduce sperm maturation steps, and 2-methoxyethanol administration to pregnant mice delays neurogenesis and morphogenesis, specifically neural tube closure and limb and digit formation. Butoxyethanol has been identified as potentially toxic to the bone marrow, leading to haemolysis, haemoglobinuria, leukopenia, and decreased bone marrow cellularity. Lymphatic damage is also observed in Ethylene glycol ether. Dermatologic injury is another concern, as glycol ethers are easily absorbed through the skin. [6]

Borax:

Borax is widely used as a household cleaner and a booster for laundry detergent.It is commonly available in powder or granular form and has many industrial and household uses, including as a pesticide, as a metal soldering flux, as a component of glass, enamel, and pottery glazes, for tanning of skins and hides, for artificial aging of wood, as a preservative against wood fungus, and as a pharmaceutic alkalizer. The majority of toxicity data on boron are on boric acid. Boron in the form of boric acid is readily taken up over the gastrointestinal tract. Intact skin seems to pose a more effective barrier than compromised skin. Boron excretion seems to mainly occur via the urine, although after skin intoxication, it has been detected in bile and gastrointestinal contents. Overexposure to borax dust can cause respiratory irritation, while no skin irritation is known to exist due to external borax exposure. Ingestion may cause gastrointestinal distress including nausea, persistent vomiting, abdominal pain, and diarrhea. Effects on the vascular system and human brain include headaches and lethargy but are less frequent. In severe cases, a "beefy" red rash affecting the palms, soles, buttocks and scrotum has occurred. [7]

Hydrocarbons:

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. 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. Hydrocarbon toxicity is determined by various factors, including physical and chemical characteristics, dose and concentration, additives, and routes of exposure. Aspiration risk is directly related to physical characteristics such as viscosity, surface tension, and volatility. Lower viscosity, lower surface tension, and higher volatility increase the risk of aspiration and subsequently, toxicity. Inhalation or ingestion can both allow for easy absorption of the hydrocarbon, leading to systemic toxicity. The pulmonary system is most commonly affected by inhalation or aspiration, with multiple systems in the body potentially affected by these same routes of exposure. Pulmonary toxicity from inhalation or aspiration occurs from direct toxicity, leading to hydrocarbon pneumonitis, which can lead to acute respiratory distress syndrome due to increased vascular permeability and edema. Rarer pulmonary complications include lung necrosis, pneumothorax, pneumatocele, or bronchopleural fistula. Cardiac toxicity is also a possibility following hydrocarbon exposure, with life-threatening dysrhythmias such as ventricular tachycardia or fibrillation. "Sudden sniffing death syndrome" has been described in hydrocarbon abusers, occurring shortly after exposure often without any preceding symptoms. The primary CNS effect associated with hydrocarbon toxicity is a decreased level of consciousness, with multiple pathways leading to this decreased level of consciousness. Other systems are also commonly affected by hydrocarbons, including gastrointestinal (GI) irritants, hepatic damage, and hematologic disorders. Rashes may be noted over the face or on the hands of habitual inhalation users, while dermatitis, cellulitis, and soft tissue necrosis are also possible depending on the method of exposure. [8]

Volatile organic compounds:

Volatile organic compounds (VOCs) are released from many household cleaning products such as disinfectants, polishes, floor waxes, air-freshening sprays, all-purpose cleaning sprays, and glass cleaner. VOCs are responsible for the odor of scents and perfumes as well as pollutants. VOCs are emitted by thousands of indoor products. Examples include: paints, varnishes, waxes and lacquers, paint strippers, cleaning and personal care products,

pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions. Human activities such as cooking and cleaning can also emit VOCs. Cooking can release long-chain aldehydes and alkanes when oil is heated and terpnes can be released when spices are prepared and/or cooked. Cleaning products contain a range of VOCs, including monoterpenes, sesquiterpenes, alcohols and esters. Once released into the air, VOCs can undergo reactions with ozone and hydroxyl radicals to produce other VOCs, such as formaldehyde These products have been shown to emit irritating vapors. VOCs tend to evaporate and then to be inhaled into the lungs or adsorbed by dust, which can also be inhaled. Aerosolized (spray) cleaning products are important risk factors and may aggravate symptoms of adult asthma, respiratory irritation, childhood asthma, wheeze, bronchitis, and allergy. Health effects include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidney, and central nervous system. Some VOCs are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, vomiting, nose bleeding, fatigue, dizziness. [9]

Conclusion:

Despite being useful for maintenance and cleaning, household chemicals entail significant risks to health owing to their pharmacological attributes. Understanding the mechanisms of action and potential health impacts of these substances is crucial for safe handling.

References:

1. Mar, S., Liang, S., Waltz, M., Casper, T. C., Goyal, M., Greenberg, B., Weinstock-Guttman, B., Rodriguez, M., Aaen, G., Belman, A., Barcellos, L. F., Rose, J., Gorman, M., Benson, L., Candee, M., Chitnis, T., Harris, Y., Kahn, I., Roalsted, S., Hart, J., …U.S. Network of Pediatric Multiple Sclerosis Centers (2018). Several household chemical exposures are associated with pediatric-onset multiple sclerosis. *Annals of clinical and translational neurology*, *5*(12), 1513–1521. https://doi.org/10.1002/acn3.663
2. Speight, J. G. (2018). Chemicals in the environment. In Elsevier eBooks (pp. 43–79). https://doi.org/10.1016/b978-0-12-804422-3.00002-x
3. Slaughter, R. J., Watts, M., Vale, J. A., Grieve, J. R., & Schep, L. J. (2019). The clinical toxicology of sodium hypochlorite. *Clinical Toxicology*, *57*(5), 303–311. https://doi.org/10.1080/15563650.2018.1543889
4. Appl, M. (2006). Ammonia. Ullmann's Encyclopedia of Industrial Chemistry. https://doi.org/10.1002/14356007.a02_143.pub2
5. National Academies Press (US). (1984). *ISOPROPYL ALCOHOL*. Emergency and Continuous Exposure Limits for Selected Airborne Contaminants - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK208299/
6. Shafiee, A., Khoobi, M., & Nadri, H. (2014). Glycol ethers. In Elsevier eBooks (pp. 762–766). https://doi.org/10.1016/b978-0-12-386454-3.00729-6
7. Hadrup, N., Frederiksen, M., & Sharma, A. K. (2021). Toxicity of boric acid, borax and other boron containing compounds: A review. Regulatory Toxicology and Pharmacology, 121, 104873. https://doi.org/10.1016/j.yrtph.2021.104873
8. Brown, K. W., & Armstrong, T. J. (2023, April 7). Hydrocarbon inhalation. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK470289/
9. Wolkoff, P., Wilkins, C. K., Clausen, P. A., & Nielsen, G. D. (2006). Organic compounds in office environments - sensory irritation, odor, measurements and the role of reactive chemistry. Indoor Air, 16(1), 7–19. https://doi.org/10.1111/j.1600-0668.2005.00393.x