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Review on the Effects of Chemical Compounds Toxicity on Workers in Chemical Laboratories

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Abstract

Chemical laboratories are considered high-risk work environments due to the wide range of chemicals that workers handle, which may be toxic, corrosive, or flammable. Improper handling of these substances can lead to serious health problems, ranging from mild irritation to death in cases of exposure to chemical compounds, such as phenols and amines, which cause various types of lung and laryngeal cancers and respiratory diseases in laboratory workers who are in direct contact with hazardous laboratory materials. Inhaling the fumes of some gaseous substances can lead to pneumonia, chronic bronchial allergies, and difficulty breathing. Some chemicals are irritants to the respiratory membranes and skin, causing short-term symptoms upon exposure such as inflammation, rashes, redness, allergic reactions, bleeding, or coughing. These symptoms can affect the skin, eyes, and respiratory system. Irritants also damage the ozone layer and thus pose a risk to public health. Examples include chlorine, ammonia, sulfur dioxide, poison ivy, chromic acid, and nickel chloride. There are organic compounds that cause skin erosion or skin irritation upon contact; these are known as corrosive substances. These chemicals lead to the erosion or destruction of the part they come into contact with, such as skin, which can suffer severe burns and tissue damage if exposed to any of these substances. Examples of corrosive substances include sodium hydroxide, acetic acid, hydrochloric acid, bromine, and perchloric acid. From all of this, we can conclude that chemical hazards in the workplace, whether in a laboratory or a chemical plant, are threats arising from the presence of chemicals that may cause health and environmental damage, such as fires and explosions, and expose workers to harm such as irritation, burns, and respiratory distress. Types of chemical hazards include flammable, irritant, carcinogenic, explosive, toxic, and other substances. To avoid these hazards, employees must be educated, protective equipment provided, safety labels used, and materials stored correctly.

Keywords: Toxicity of chemicals, hazardous materials, toxic, corrosive, flammable

INTRODUCTION

Chemical hazards in the workplace include flammable compounds and materials that can cause fires, explosions, or health problems such as irritation and burns. To manage these hazards, employees must be educated, protective equipment provided, and safety labels used. Risk management involves identifying, assessing, and controlling hazardous materials through replacement or the use of personal protective equipment. Maintaining a safe work environment also requires regular inspections and the continuous implementation of control measures. Workplace safety is a top priority for successful organizations when creating a safe working environment for their employees. The safer the work environment, the more focused employees will be, the better their performance and productivity will be. To improve workplace safety, organizations must understand potential hazards and develop plans to mitigate or

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minimize their negative impacts. Chemical hazards are among the most prominent workplace hazards. This article explains what chemical hazards are, their types, examples, negative effects, how to avoid them, and the steps involved in identifying and managing chemical hazards. Hazardous chemicals are classified according to their type and the degree of their inherent health and physical hazards. The hazardous properties of a mixture of two or more chemicals are determined by assessing the inherent risks in these substances [1, 2].

CHEMICAL HAZARDS

Chemical hazards arise from the presence of materials with chemical properties that cause environmental risks, such as fires and explosions, as well as health hazards such as skin irritation, burns, respiratory distress, and other long-term health problems. Many organizations rely on the use of solid, liquid, or gaseous chemicals in various products and processes. This increases the likelihood of employees being exposed to these hazards, especially when they come into contact with or are mixed up with other chemicals. Given the negative consequences of exposure to chemical hazards, organizations must educate their employees about these risks and train them on how to handle them correctly. This includes providing necessary protective equipment, ensuring safety labels are affixed to all chemical containers, clearly identifying and properly storing flammable materials, and outlining how to respond to fires in emergencies. Toxic substances can cause harm if swallowed, so do not eat or drink anything in the lab, and do not put your fingers or hands in your mouth. Chemicals can also enter the body in several other ways, as previously mentioned. Until you have washed your hands thoroughly and left the lab, keep them away from your eyes, ears, and nose. Also, keep your hands away from any cuts, burns, or abrasions on your skin. If you must use needles or handle glassware, practice doing so thoroughly to avoid injuring yourself [3].

Some toxic substances can be absorbed directly through the skin. If you find such a substance, the label on the container and the chemical information card will explain this danger. When handling such materials, make sure you wear chemical-resistant gloves and dispose of them immediately after use, as instructed by your instructor. Wash your hands thoroughly with water after removing the gloves. If a chemical is spilled, splashed, or gets on your skin or clothes, wash it immediately with water for at least 15 minutes. Always wash your hands thoroughly before leaving the laboratory. Workers in microbiological laboratories are exposed not only to disease-causing microorganisms, but also to chemicals. It is important that they have adequate knowledge of the toxic effects of these chemicals, the routes of exposure, and the hazards that may be associated with handling and storage. Toxicology Data Sheets (SDS), which describe the hazards associated with the use of a particular chemical, are available from the manufacturers and/or suppliers of the chemicals [4].

IDENTIFYING HAZARDOUS CHEMICALS FOR WORKERS IN CHEMICAL LABORATORIES

Initially, it is necessary to identify and diagnose hazardous compounds to determine which chemicals pose a risk in the workplace. The manufacturer, supplier, or importer of hazardous chemicals prepares a Safety Data Sheet (SDS) for each substance used or stored in the workplace. This sheet contains the word "hazard" or "warning" and a statement explaining information about the hazard, such as eye or skin irritation, in addition to information about the safety precautions that must be taken, the method of storage, fire-fighting equipment, personal protective equipment, emergency measures to be taken in case of an accident, and other important information. Toxins affect cells as soon as they come into contact with them, and therefore, their symptoms begin after ingestion. A severe, burning pain starts in the mouth and lips and extends to the pharynx, esophagus, and stomach [5]. The pain then spreads, accompanied by frequent vomiting of black bile (acidic and alkaline), until the entire abdomen is filled with it. The patient also experiences intense thirst and constipation in the case of acid poisoning, and diarrhea in the case of alkali poisoning, along with decreased urination and difficulty breathing, swallowing, and speaking. The immediate cause of death in these cases, especially in cases of poisoning, is due to nervous shock and general weakness, or to suffocation resulting from edema of the tongue caused by ammonia vapors, nitric acid, or acetic acid. Death can also result from stomach perforation, leading to acute peritonitis. Delayed death is caused by exhaustion resulting from esophageal stricture. The assignment of a pathogen to a biotoxicity level must be based on a risk assessment. Such an assessment will consider the risk profile as well as other factors when determining the appropriate biotoxicity level [6]. For example, a pathogen assigned to risk profile 2 may generally require biotoxicity level 2 facilities, equipment, practices, and procedures for safe working behavior. However, if certain experiments require the generation of a highly concentrated aerosol (spray), a biotoxicity level of 3 may be more appropriate to provide the necessary degree of toxicity, as it ensures containment within the laboratory environment. Therefore, the biotoxicity level assigned to the specific task to be performed is based on a risk assessment. The determination of the biotoxicity level considers the organism, driven by professional judgment based on the user's needs. The causative agent of the disease, available facilities, practices, procedures, and equipment required for safe work in the laboratory. Chemicals are used not only in the chemical industry but are also widely used in all fields of work [7].

Although data on exposure in specific sectors is limited, recent evidence illustrates the scale of the risks globally. Occupational exposure to mercury is believed to affect more than 19 million artisanal gold miners, and the risk of exposure to pesticides and other agricultural chemicals affects approximately 873 million small-scale workers. Many countries are still struggling to regulate long-recognized risks, such as those in agriculture, caused by pesticides and heavy metals, and are also facing new concerns related to substances such as endocrine disruptors, perfluorinated chemicals, and perfluorinated compounds. The health effects of chemical exposure range from acute poisoning and injuries to chronic diseases such as cancer, respiratory and cardiovascular diseases, toxic neurological syndromes, reproductive disorders, and problems. Exposure to heavy metals, such as lead, leads to kidney dysfunction, high blood pressure, and growth disorders. It is estimated that it causes more than 1.5 million deaths annually worldwide. Exposure to mercury in mines can lead to chronic mercury vapor poisoning, a disease that affects between 3.3 and 6.5 million workers [8].

CATEGORIES OF HAZARDOUS COMPOUNDS AND CHEMICALS

Hazardous chemicals refer to highly toxic chemicals that are poisonous, corrosive, explosive, flammable, and combustible, and are harmful to humans, facilities, and the environment. According to the latest "Hazardous Chemicals Catalog," there are a total of 2,828 hazardous chemicals. In fact, let us not even get started on the term "hazardous." Our production and daily lives are inextricably linked to hazardous chemicals such as liquefied petroleum gas (LPG), natural gas, gasoline, glue, paint, varnish, liquid ammonia, pesticides, caustic soda, sulfuric acid, hydrochloric acid, etc.

- *Toxic Substances:* Theoretically, we can classify all substances as toxic when their use or consumption exceeds safe limits. However, it is generally accepted that some substances are toxic when ingested, inhaled, or swallowed in small doses such as cyanide compounds or carbon monoxide and carbon dioxide. A concentration of 0.2% carbon monoxide in the atmosphere is considered lethal if inhaled for one hour.
- *Carcinogens:* Some important reagents used in laboratories for certain detection and analytical reactions include cyclic amines and nitro compounds such as diammonium nitro-amine, toluene, benzene, chloroform, formaldehyde, benzidine, iodine, asbestos, and many others. Even brief exposure to some of these substances, and continuous exposure to others, can lead to accumulation and cancer, whether through skin contact, ingestion, or inhalation. Therefore, some international organizations strictly prohibit the handling of certain materials such as naphthalamine and benzidine.
- *Flammable and Explosive Materials:* Explosions occur using certain chemicals, such as perchloric acid, which is also used for cleaning and dissolving organic materials, and dry picric acid (also known as bitter acid) is used as a cleaning agent and also as a chemical weapon. Some organic solvents, such as ether, can also cause explosions, as their oxidation results in high heat dissipation [9, 10].
- *Radioactive Materials:* Science distinguishes between two types of radiation:
  - Non-ionizing radiation such as radio waves, television waves, and light.
  - Ionizing radiation, also known as nuclear radiation.

Nuclear radiation is frequently used in biochemistry laboratories as it forms the basis for biometric measurements, particularly hormone measurements. Examples include X-rays, used in standard radiography laboratories, and gamma, alpha, and beta rays, used in radioisotope applications, which have become increasingly common in modern analytical laboratories, There are types of containers in Figures 1 & 2.

Figure 1. Leak-proof and corrosion-resistant containers.

Figure 2. Containers are resistant to explosive materials and gas leaks.

METHODS OF CHEMICAL EXPOSURE

The respiratory system is one of the most important entry points for toxic substances into the body. Inhaling vapors, gases, and particulate matter suspended in the air and becoming trapped in the lungs and other respiratory tracts can cause severe damage. Furthermore, these substances can penetrate these tracts to other organs via the bloodstream and lymphatic vessels, leading to their spread throughout the body. Sometimes, substances are transmitted through vaccination or the use of syringes or laboratory equipment. Contact with injection needles or equipment previously contaminated with toxic substances can lead to the direct transfer of these substances into the body, as is the case with chromatography equipment [11].

Consequently, all these methods can result in absorption through the bloodstream, entering tissues and accumulating until critical concentrations are reached, at which point symptoms begin to appear after a period, as is the case with lead ions and carcinogens. The most serious of these effects are cancer or damage to the liver, lungs, or kidneys. In addition, these substances can be transmitted to the fetus in pregnant women, causing fetal death. Other materials leak and cause corrosion of the surfaces of containers and tanks that hold them, eventually evaporating and harming laboratory workers. Materials classified as hazardous in this category cause leakage through their chemical activity. When they come into contact with living tissue, they cause severe damage, as does leakage into surrounding containers and other goods. In many cases, this results in the release of gases, some toxic and others potentially harmful. Mixing these gases with the atmosphere can cause explosions and ignitions [12, 13].

The dangers of chemical materials, such as liquids, gases, fumes, vapors, and dust that students and workers in scientific laboratories face during practical experiments, and in industrial workshops during the handling and storage of these materials, have become a major concern in the lives of individuals and communities. Chemicals play a vital role. The well-being and progress of nations are measured by their advancements in discovering and using chemical substances in various aspects of life. The use of chemicals is a double-edged sword. If used properly, they represent the bright and beneficial side of humanity. However, if misused, they reveal the ugly side that causes the destruction of humanity and wastes the lives of individuals. Chemicals exist in the work environment in one of several forms: organic compounds such as phenols and aromatic amines, vapors such as mercury, toxic gases, or other substances such as organic and inorganic acids and bases. Chemicals can cause hazards if not handled correctly. For example, they can be toxic, flammable, corrosive, or radioactive. Some chemicals may have just one of the hazards mentioned above, or they may combine two or more.

They may be hazardous in one way or another, and the degree of hazard varies. Every chemical, even water, can be highly hazardous, low-risk, or somewhere in between. For example, both gasoline and alcohol are flammable, but gasoline is more flammable than alcohol. Gasoline is easier to ignite and burns more violently, or it is more explosive than alcohol. In all cases, you can work safely by following the warnings on the chemical label and also the Safety Information Sheet (MSDS). The subject teacher or lab supervisor can also explain the dangers of the materials you use, as well as the safety precautions you should take while working in the lab [14, 15].

CHEMICAL POISONING WITH HEAVY METALS

The most dangerous symptom of lead poisoning in general, and what is known as lead brain disease (encephalopathy), is as follows:

It arises because of a high level of lead in the blood, allowing it to cross the blood–brain barrier, thus affecting the nervous system. Symptoms appear as epileptic seizures followed by a coma that may lead to the death of the poisoned person. As for the symptoms of chronic lead poisoning, they manifest in several ways, including reduced nerve conduction, which ultimately leads to motor neuropathy in the form of wrist and ankle joint drop. As a result of lead inhibiting the enzymes responsible for the synthesis of heme in the blood, anemia occurs, and the precursors for heme synthesis accumulate in red blood cells in the form of bluish spots, contributing to the development of hemoglobin. In helping to diagnose chronic lead poisoning through blood sample testing [16].

Toxic Agents in Chemical Laboratories

Carbon monoxide is odorless and highly fat-soluble, so it diffuses through the lungs into the bloodstream and binds to hemoglobin, causing suffocation without warning. Hydrogen chloride gas, being water-soluble, dissolves in the moist respiratory tract, causing immediate throat irritation. This property limits the amount that can reach the deep lungs, but it concentrates on the damage in the upper airways. Powders, like silica, are not chemically toxic, but if ground into fine, respirable particles, they are released into alveoli and cause chronic lung disease [17]. The behavior of each chemical – how quickly it evaporates, whether it dissolves in water or fats, and how it reacts in the body – will determine the resulting health risks. Many organic solvents also cause central nervous system spasms in cases of acute poisoning. This leads to symptoms ranging from dizziness, nausea, and confusion to loss of consciousness or coma. Chloroform, ethyl ether, toluene, and halothane are classic anesthetics; high vapor exposure will induce drowsiness and can progress to deep anesthesia (loss of protective reflexes). Victims may appear intoxicated or sedated. At extreme levels, respiratory arrest can occur. In laboratories, a sudden solvent leak in a small room or the improper use of anesthetic gases can lead to this outcome. The global economy relies on numerous volatile or hazardous chemicals for production and manufacturing. Petrochemicals, polymers, rubber, agricultural chemicals, and much more are needed to maintain complex supply chains that flow around the world. Industrial work sites often use, store, and dispose of these chemicals to manufacture products from raw materials [18].

When handling these inherently hazardous materials, workers and visitors at industrial plants must be protected through a range of safety practices, equipment, and planning. In this article, we will provide an overview of the vital importance of proper chemical process safety and then cover five safety tips and standards that engineers and managers should implement in their facilities. Some chemicals are inherently toxic or produce toxic byproducts when exposed to abnormal conditions such as heat, humidity, acids, etc. If such hazardous toxic materials are required in a laboratory, they must be stored in a toxic chemicals tank, which is usually located under the fume hood and connected to it by a small ventilation opening. These toxic materials must be clearly labeled, indicating their level of danger. Large quantities must be stored in a secure location, away from flammable materials and in a fire-resistant area. The removal of toxic materials from storage must be strictly controlled. Complete information must be recorded about the person receiving the material, the quantity, and their signature, acknowledging their responsibility for the material while it is outside the storage area. The person receiving the material is obligated to return any excess to the storage area upon completion, paying attention to the expiration date and whether the material is volatile, leaking, or gaseous. Explosive materials are very sensitive; therefore, they must be stored under strict control in a secure, well-secured building accessible only to the designated person responsible for the entry and exit of these dangerous materials. The quantity of stored explosives must be kept to a minimum. The distance of the explosives storage facility from other buildings depends on the quantity of explosives stored, and there are internationally agreed-upon distances. The explosives symbol is used to warn of the danger, depending on the quantity of stored explosives [19].

Laboratory Chemical Hazards

In industrial work environments, such as production, manufacturing, and refining facilities, chemical safety is a major concern for site owners, supervisors, and frontline workers alike. Depending on the industry, plant, and environment, flammable and toxic chemicals may be used in manufacturing processes or other applications. While industrial chemicals serve a variety of important purposes, handling and using these chemicals presents unique safety challenges and hazards that can affect workers, the environment, and the public. For example, improper handling of flammable or toxic chemicals can lead to adverse environmental impacts or public health concerns. Furthermore, inadequate safety in chemical processes can increase the risk of injury to workers who handle or work around hazardous materials.

TYPES OF POISONING WITH CHEMICAL OR BIOCHEMICAL SUBSTANCES

Safety is not just a set of rules on the wall; it is an integrated culture and mindset that is ingrained in every step a chemist takes. It is the difference between a successful experiment and a potential disaster. Mastering (laboratory safety practices) is not an option, but rather a prerequisite for practicing science responsibly. This guide is not just a list of do’s and don’ts, it is a journey to understand the “why” behind each action, to build a safety instinct that protects your life and the lives of those around you.

- *Health Hazard:* It includes several classifications, such as acute toxicity, skin corrosion/irritation, serious eye damage, skin or respiratory allergy, in addition to cancerous mutations in cells, harm to the reproductive system, danger to a specific organ of the body because of continuous exposure, and so on.
- *Physical Hazard:* These include explosives, gases, liquids, oxidizing solids, flammable liquids, gases, and solids, in addition to aerosols, self-flammable liquids and gases, organic peroxides, and metal-irritating materials.
- *Environmental Hazard:* It is classified as substances dangerous to the aquatic environment, and substances dangerous to the ozone layer [20].

CHEMICAL RISKS IN CHEMICAL CEMENT FACTORIES

Despite the effectiveness of cement in construction, its manufacture includes a series of negatives that affect the surrounding environment, which exposes the lives of living organisms to a series of dangerous diseases. Diseases resulting from cement manufacturing and handling of cement are serious diseases that lead to death, including cement saturated lung disease (ASBSTOSE), which is a linear fibrosis that affects the respiratory bronchioles and lungs, resulting from inhaling cement dust, depending on its size.

Medium and large particles larger than 10 microns are more likely to cause fibrosis. The way to prevent this dangerous disease is to work in a humid atmosphere or in covered equipment placed in low places. Workers must take anti-dust masks, and the atmosphere or air must be monitored at least once a month. No worker may be accepted without a certificate of competency from the workers' doctor, and this certificate must be renewed at least once a year. Workers underage are not accepted Under 18 years of age, who suffer from total disability or poor health. There is also a lung-preserving disease (silicoses). This disease results from inhaling silicium oxide dust or free siliceous SiO, and the latter is the only one that causes a lung-preserving disease, as the works that produce dust contain it, which is a particle with a diameter of less than (5 microns), and the danger begins when the number of particles exceeds 3000–4000 particles (cubic centimeter) of air, and prevention of this disease. There is no treatment that can stop the process of pulmonary fibrosis. Except by keeping the worker away from dust. Studies also indicate that there is another disease, which is dermatitis. This disease is the most common occupational disease and causes skin infections. The people exposed to these infections are those who deal with cement and those who carry it in the cement factory. These infections are observed in the neck and shoulders of people who exercise

When transporting cement, especially for 4 days in hot weather, cement has a basic intensity (pH > 10), so it has a burning and inflammatory role at the level of the respiratory tract, causing inflammation of the nasal mucosa that can develop into perforation of the nasal septum and inflammation of the bronchial tubes. Even if this exposure to dust is severe and long-term, it leads to chronic bronchial inflammation (Branchiate). Among the organs most susceptible to dermatitis we find: (the back, hands, fingers, nails, feet, face), and at the eye level, it leads to severe infections such as inflammation of the connective tissues and eyelids, and 4 types of allergies appear (such as acute eye inflammation, tears, and a tumor observed on the eyebrow). To prevent it, we must reduce skin contact with cement by using gloves and acidic and greasy clothes – care.

Good physical hygiene, along with washing hands with pure water – Every skin irritation must be treated well – New workers working with cement must undergo medical examination, as people with sensitive skin cannot work in these places – Workers must have healthy respiratory tracts, which are looked after by a doctor during several regular periodic examinations – Handling cement also affects a person's sense of hearing, and this is done through noise that is unhealthy for the factory workers and the population. Neighboring people can cause diseases such as high blood pressure. To prevent this, intervention must be made at the machine or equipment level by placing materials or changing some parts – the noisiest machines must be isolated in special places – workers must wear masks and ear plugs [21–23].

Cement factories have negative effects on animals, as their food is a mixture of grass and cement, thus eliminating their genetic cycle. Cement factories also pose some negative effects on plants. One of the most serious negatives of the cement industry is the bad impact on the environment and the threat to the surrounding area through the secretions that industrial units excrete gaseous and liquid waste, which have a negative impact on the vegetation cover such as the accumulation of a thick layer of dust. Cement on tree leaves leads to poor production of vegetables and fruits, in addition to the risk of poisoning humans when eating them, as well as animals when eating herbs. Never pour chemical waste into the sink or water drains that are not intended for it or throw it in regular trash. Waste should be separated and collected in designated containers that are clearly labeled according to its category (e.g., waste chlorinated solvents, waste acids, etc.). Always follow your organization's approved waste disposal protocol. Workers in chemical factories or industry in its three stages are exposed to dust, heat, and noise. The most common diseases to which workers are exposed are:

- Respiratory diseases, due to inhaling air contaminated with dust from cement compounds and gases emitted, especially in the second stage of manufacturing. It has been noted in international statistics that /3%/ of workers did not show symptoms of respiratory diseases. The most common respiratory diseases are A – Lung saturation with cement, which is fibrosis that affects the lung due to cement particles that may reach 10 Micro. B – Lung failure due to inhalation of silicium oxide dust, which is usually made up of particles with a diameter of less than 5 microns, and its danger begins and increases when the number of particles reaches 200 per cubic centimeter of air. This disease often has no treatment to stop the fibrosis process, except removing the infected person from the source of pollution permanently. The most important means of prevention that must be provided to the worker, and the work environment, are anti-dust masks, monitoring the air atmosphere at least once every 15 days, low suction devices, and reducing working hours.
- Dermatitis is one of the most common occupational diseases to which workers who deal with cement directly in the factory are exposed, especially carrying and packing workers, and its effects appear in the hands and feet (fingers and nails), causing cement eczema, and on the face at the level of the eyes.
- The digestive system of workers in the cement industry often suffers from gastric ulcers, and the infection rate is estimated at 5% among workers [24–27].

LABORATORY TOXICITY MEASUREMENT

Toxicity is measured using the LD50 scale, which represents the lowest dose that can kill 50% of the test animals. A lower LD50 indicates a higher toxicity of the compound. It is worth noting that experiments vary depending on the type of test animal, such as mice, dogs, monkeys, or others, depending on the substance being tested. Chemical substances vary in their toxicity, and consequently, in the speed at which symptoms of poisoning appear and the route of entry into the body. The concentrations and critical time intervals required vary according to the toxicity of the substance, ranging from fractions of a microgram to a few grams per liter, and the time intervals can range from a few hours to several years. For example, radioactive materials, such as uranium and radium, can cause chronic poisoning if small amounts are ingested and the body cannot eliminate them, causing them to remain for a long period [28]. In contrast, other substances, such as lead and cadmium compounds, only cause poisoning with ingestion of larger doses and relatively long periods of exposure. There is no doubt that chemicals have played a vital role in the development of human societies through their use in all scientific, industrial, agricultural, petroleum, medical, commercial, military, and domestic activities. While chemicals have helped raise the standard of living, they have also exposed human health and the environment to numerous risks during their production, transportation, storage, use, and disposal. Indeed, finding solutions to chemical safety issues is a factor that permeates almost all aspects of life, considering their role in generating hazardous waste, causing environmental pollution, and leading to various problems. Furthermore, they represent a human concern that may arise from the production and release of countless chemical compounds and products onto the market. To reduce the health and environmental risks arising from chemical handling, it is necessary to develop special chemical safety plans and systems that include safe methods for managing, transporting, and storing chemicals, and subsequently recycling them [29–30].

CONCLUSIONS

Chemical laboratory workers must learn how to manage chemical hazards. This requires identifying hazardous materials, assessing risks, controlling them through procedures such as replacing hazardous materials or using personal protective equipment, and implementing sound monitoring measures. Containers must also be clearly labeled, and regular inspections conducted to ensure that measures are effectively implemented. In conclusion, organizations that follow the necessary protection measures against hazardous chemicals contribute to providing a safe working environment and ensure the safety of workers from chemical hazards.

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