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EXPOSURE TO HAZARDOUS CHEMICALS AT WORK AND PREVENTION IN INDUSTRIES

K. MAGAPRASANNA[1], DR.M. BHUVANESHWARAN[2]
1 PG STUDENT, 2 ASSOCIATE PROFESSOR
INDUSTRIAL SAFETY ENGINEERING
K.S.R. COLLEGE OF ENGINEERING, TAMILNADU, INDIA

ABSTRACT

Chemical hazards are a major occupational health and safety (OHS) issue in Pharma industry. Management of chemical hazards requires the combined efforts of OHS specialists, including generalist OHS professionals, occupational hygienists, and occupational health practitioners. This paper is about industrial chemicals, the manner in which their toxicity is assessed and the use of such assessments in regulatory decision-making. It begins with general points concerning toxicological data availability and hazard identification, then moves on to risk assessment and occupational exposure limits, and finally looks briefly at three specific toxicological issues, asthma, chronic toxic encephalopathy, and ‘‘low toxicity’’ dust effects on the lung, where the science is far from resolved after brief consideration of the historical context of chemical reactivity and toxicity issues, acute and chronic exposure, chemical hazard classification systems, and the identification, risk assessment, and control of chemical hazards. Preventing exposure to toxic chemicals is a primary concern at hazardous waste sites. Most sites contain a variety of chemical substances in gaseous, liquid, or solid form. These substances can enter the unprotected body by inhalation, skin absorption, ingestion, or through a puncture wound (injection). Emphasis is placed on the importance of working with a range of OHS specialists to ensure a range of skills is directed at preventing fatality, injury, disease, and ill health arising from this complex area of OHS.

KEY WORDS: Dangerous goods, globally harmonized system, Hazardous chemical, Hazardous substance, Occupational exposure standard, Occupational hygiene

1. INTRODUCTION

Chemicals are used to make virtually every man-made product and play an important role in the everyday life of people around the world. The chemical industry is the third largest industrial sector in the world. It is also a major economic force. Worldwide, it employs some 10 million people and generates billions of euros in shareholder value and tax revenue for governments. The pharmaceutical industry has been described as dynamic and growing, in terms of sales, number of employees, and gross domestic product (GDP). It is an industry in which companies, government regulators and researchers focus on the “safety” of the products and their effects on end users and the environment. Chemical hazards produce by chemical synthesis or manufacturing, processing, transportation and that effect on the human and environmental condition. A chemical hazard is a type of occupational hazard caused by exposure to chemicals in the workplace. Exposure to chemicals in the workplace can cause acute or long-term detrimental health effects. There are many types of hazardous chemicals, including neurotoxins, immune agents, dermatologic agents, carcinogens, reproductive toxins, systemic toxins, asthma genes, pneumoconiotic agents, and sensitizers. [1,2] Little is known about the health risks of working in the pharmaceutical industry. On the surface, the industry looks clean. The production of medicinals demands a carefully maintained and sterile working environment and the white lab coats worn by workers add to the illusion of safety. The appearances are deceptive, though producing drugs and other medicinals may involve exposure to toxic industrial chemicals. And while the finished products may be lifesaving medications for sick people, they can be dangerousto healthy workers who are inhaling or absorbing

1.1 AIMS OF THIS THESIS

This thesis focuses on one area of regulation and one tool of risk management: OELs. Describing similarities between countries in selection of what substances to regulate and comparing the average level of OELs was the first aim. This was followed by a focus on the European Union and questions about whether the EU OELs have had any influence on the national states concerning which substances to regulate and the levels of the OELs. The final aim of this thesis is also to describe how some of the currently enforced OELs are substantiated. By such a study of OELs and substantiating documents the main objective is to uncover possible discrepancies and to produce knowledge that can help improve the risk decision process. I also wish to put the setting of OELs in a context of general risk assessment.

2. CHEMICAL EXPOSURE

2.1 ASBESTOS

Occupational exposure through inhalation, and to a lesser extent ingestion, occurs in the mining and milling of asbestos (or other minerals contaminated with asbestos), the manufacturing or use of products containing asbestos, construction, automotive industry, and the asbestos-abatement industry (including the transport and disposal of asbestos-containing waste). At present, more than 50 countries have banned asbestos. Unfortunately, as the developed world was phasing out or restricting the use of asbestos, LMICs were greatly increasing use of this toxic material. The current world total production is still estimated to be 1,100,000 metric tons (Bernhardt and Reilly 2019). Peak world production was estimated to be 5,090,000 metric tons in 1975, with approximately 25 countries producing asbestos and 85 countries manufacturing asbestos products (Nishikawa et al. 2008). Currently about 125 million people in the world are exposed to asbestos at the workplace (WHO 2018). The United States Occupational Safety and Health administration (OSHA) estimated in 2008 that 1.3 million employees in construction and general industry faced significant asbestos exposure on the job in the United States of America (OSHA, 2008). In Europe, estimates of the number of workers exposed to asbestos have been developed by the CAREX study. Based on occupational exposure to known and suspected carcinogens collected during 1990–93, the CAREX database estimates that a total of 1.2 million workers were exposed to asbestos in 41 industries in the 15 Member States of the EU (EU-OSHA 2014). CAREX Canada estimates that 152,000 Canadians are exposed to asbestos in their workplaces (CAREXCanada 2020).

2.2 SILICA

Occupational exposure to respirable c-silica most frequently occurs at a wide range of processing and construction sites, such as metal, nonmetal, and coal mines and mills; granite quarrying and processing sites; hydraulic fracturing operations; crushed-stone industries; foundries; ceramics; and sandblasting operations (NTP 2016). Silica can also contaminate other ore or materials being mined, or a mining environment, thus inadvert-ently exposing workers. For example, substantial exposure to respirable c-silica occurs amongst coal miners in the central Appalachian coal mines in the United States, where thin seams of coal lie sandwiched between silica-rich sandstone. The major component of sand and gravel is c-silica. The quartz/c-silica content of crushed stone varies from region to region

2.3 DYES

Dyes are chemical substances that bond to a substrate and are classified according to them chemical properties and solubility. They are used to modify the colour of different substrates, such as textiles, paper and leather. Occupational exposures to dyes occur during their production and use. There are an estimated 800 dyes currently in use, including azo dyes (Licina et al. 2019). Although originally from natural sources, modern dyes are synthetic substances which can be hazardous to health and polluting to the environment. The global demand of dyestuff corresponds to approximately 9 million tonnes (Rawat et al. 2016), with azo dyes making up greater than 70 per cent of this figure (Benkhaya et al. 2020). The textile industry consumes two-thirds of production worldwide, however dyes are also commonly used in pharmaceuticals, food and cosmetics (Venturacamargo, Marinmorales 2013). Some azo dyes degrade under certain conditions, leading to the release of carcinogenic aromatic amines, such as aniline, benzidine and 2-naphthylamine (Licina et al. 2019).

2.4 MANUFACTURED NANOMATERIALS

In the workplace, health hazards can result from inhalation, ingestion or skin absorption of MNMs. The human lungs represent an excellent entry portal for MNMs due to their high surface area, thin epithelial barriers and extensive vasculature. While dermal and oral exposure may occur, inhalation is more likely to result in a larger systemic dose of MNMs (WHO 2017b). The global nanotechnology market is expected to grow by a compound annual growth rate of 18 per cent from US$39.2 billion in 2016 to US$90.5 billion by 2021 (BCC Research 2017). This includes the market for nanoparticle-based sunscreen products and nano-catalyst thin films for catalytic converters, thin film solar cells, nanolithographic tools and nanoscale electronic memories and many other applications (BCC Research 2017). Nanosilver, due to its antibacterial and antimicrobial properties, is widely used in the manufacture of consumer products, with most uses in electronics, information technology, health care, textiles and personal care products. Titanium dioxide and silicon dioxide nanoparticles are also widely used and constitute, together with nanosilver, 25 per cent of the nanoproducts introduced on the market (Inshakova and Inshakov 2017). MNMs are also increasingly used for pest control.

2.5 ENDOCRINE DISRUPTING CHEMICALS

Human exposures to PFAS are extremely widespread and particularly high levels are often found in workers in chemical industries. The US National Health and Nutrition Examination Survey (NHANES) reported detectable PFAS blood serum concentrations in virtually all individuals in the United States (97 percent). Workers in the chemical industries have the highest potential exposure to PFAS, followed by highly-exposed residents and then the general population. In one study of workers at the Washington Works facility in West Virginia, the average serum PFOA level in 2001–2004 was 1,000 ng/mL (Sakr et al. 2007); the mean PFOA level in highly-exposed residents (without occupational exposure) near this facility was 423 ng/mL in 2004–2005 (Emmett et al. 2006). By comparison, the geometric mean concentration of PFOA in the US population was 3.92 ng/mL

2.6 PESDICIDES

It is estimated that approximately 1.8 billion people are engaged in agricultural activities worldwide, and most use pesticides to protect food and commercial products that they produce (Carvalho 2017). During increased attention from global policy makers in the last two decades, global pesticide use has continued to grow steadily to 4.1 million tonnes per year in 2017, an increase of nearly 81% from 1990 (FAOSTAT 2019). The greatest exposure to pesticides is for agricultural workers during handling, dilution, mixing and application. Exposure is mainly by the dermal route for preparation of sprays and by the dermal and inhalation routes during application. Ingestion might occur through consumption of contaminated food during or following work or through oral contact with contaminated hands. Contaminated clothing is a significant source of exposure. Stocks of obsolete pesticides still represent an exposure hazard in many countries, in particular if storage or disposal is inappropriate

3. OPERATIONAL CONTROL MEASURES

General principles
Procedures for assessment
Review of assessment
Elimination
Control measures for chemicals hazardous to health
Control measures for flammable, dangerouslyreactive or explosive chemicals
Control measures for the storage of hazardous chemicals
Control measures for the transport of chemicals
Control measures for the disposal and treatment of chemicals
Programme for action

4. PERSONAL PROTECTION

Personal protective equipment
Respiratory protective equipment
Cleaning and maintenance of personal protectiveequipment and clothing
Welfare facilities and personal hygiene

5. MONITORING IN THE WORKPLACE

General principles
Measuring methods
Monitoring strategy
Record keeping
Interpretation and application of monitoring data

6. Medical and health surveillance

General principles
Use of results
Keeping of medical records

7. EMERGENCY PROCEDURES AND FIRST AID

Emergency procedures
First aid
Fire fighting

8. ROLE OF CONTROLLING HAZARDS

The next three sections (a planner's Guide, A Supervisor's Guide, and A Worker's Guide) Provide detailed information on the roles and responsibilities in developing and implementing effective chemical management, based on the phase in which each person fits (i.e., planning, implementation, or execution). Each section serves as a standalone guide for each phase. [32] Use the following descriptions to select the section that best applies to your role in the process: A planner's guide (blue) is for those persons (planners) responsible for planning and initially designing the chemical management process. Planning roles include but are not limited to prime contractor, owner, owner's representative, licensee, operator, and supplier. A supervisor's guide (red) is for those persons (implementers/supervisors) responsible for organizing workers and ensuring that the chemical management process gets done. Implementation roles include but are not limited to supplier, supervisor, and site supervisor. A worker's guide (green) is for those persons (executers/workers) who physically manage the chemicals on the job site and therefore are directly or indirectly exposed to the chemicals. Execution roles include but are not limited to supervisor, worker, and driver The most effective and reliable controls are those that result in the elimination of the hazardous chemical. Substitution of a hazardous chemical for a less hazardous one is the next control of choice; however, care must be taken to ensure that the substituted chemical does not introduce new hazards. Substitution also may involve using the chemical in a less hazardous form or process (e.g., use of the chemical in a pellet form rather than a dust).Isolation of the chemical in time or space from those potentially exposed can be an effective means of control (e.g., locating people in a protected control room, installing a buffer area around a chemical reactor, using the material when people are not in the vicinity).Engineering controls typically reduce exposure at the source (e.g., by enclosing the process in vessels or pipes, or by local exhaust ventilation). Prevention of uncontrolled releases is important; this may be achieved using strategies such as quantity reduction and segregation in general, administrative controls will be required to supplement higher-level controls. Administrative controls may include maintenance of equipment and training of workers and their managers in the operation of the equipment. Preventative maintenance is important in preventing uncontrolled releases. Work procedures may need to be developed to ensure that engineering controls function as designed; this includes any safe-handling procedures and special storage instructions. [33] Any residual risk may require workers to wear PPE to reduce exposure to chemicals absorbed through respiration or skin or eye contact. Specialist knowledge may be required to ensure selection of the correct type of PPE for a specific chemical.

Chemically resistant safety footwear is required. Inappropriate or poorly maintained PPE itself can act as a source of chemical exposure (e.g. contaminated gloves can be a source of ongoing exposure through persistent permeation or occlusion of the chemical inside the gloves). While it would be expected that the risk associated with tasks such as decanting of chemicals would be controlled through the enclosure or other engineering controls, some chemical handling tasks may require eye protection. Depending on the task, this may be safety goggles or full face protection. There is a wide range of PPE for respiratory protection. While Australian standards provide information on appropriate selection of respirators, the interpretation of these standard and the selection of the appropriate respiratory protection require specialist Knowledge. Fitting, maintenance and user training are important for all types of PPE, but especially for respiratory protection. [34]

9. CONCLUSION

The concluded that knowing and understanding the risk of hazardous facility and hazard release are the most important segments of an optimal pharmaceutical safety management. An effective hazard and risk assessment allows developing an incident action plan and implement strategies and tactics. The bulk of societal costs, however, are actually being borne by the workers themselves. There is an urgent need of rethinking the production process by taking into account the health impact on workers from the very beginning.

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