

EMERGENCIES IN OCCUPATIONAL ENVIRONMENT

(REVIEW ARTICLE)

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Abstract

Emergency is a serious, unexpected, and often dangerous situation requiring immediate action as it threatens serious damage to health, life, property, or environment. A workplace emergency is an unforeseen situation that threatens workers, customers, or the public; disrupts or shuts down operations; or causes physical or environmental damage. Emergencies in occupational environment include natural emergencies, fire and explosion, chemical, physical and mechanical accidents, biological exposures, and psychosocial trauma (as violence at workplace). Identification of the flammable and combustible materials stored in the workplace is a prerequisite for the developing of fire prevention plan. Gases arising from many industrial processes can be flammable and explosive, toxic, or asphyxiating. Confined spaces carry many serious risks including asphyxiation. Chemical spill can be a source of hazardous waste which necessitates emergency response. Radiation and nuclear accidents can occur if radiation sources are stored or used improperly, or safety procedures are not followed. Electrical accidents can be fatal, but they are preventable. Biohazard as infection by hepatitis B and C is present among healthcare personnel through needle stick injuries and contamination incidents. Mechanical accidents include machinery, falling and transport accidents which may result in fatality. Violence can be a source of emergency in the workplace which may lead to post-traumatic stress disorder that needs trauma intervention. Terrorism involves the deliberate use of chemical, biological, radiation or nuclear weapons. Emergency workers including firefighters, police officers, and

paramedical personnel have to deal with threatening situations. Emergency response plan outlines the resources, responsibilities and training requirements needed to deal with emergencies in a controlled manner. In Egypt, many industrial accidents are not recorded and there is lack of coordination between programs and efforts of accident prevention and preparedness.

Keywords: Emergency, Workplace, Chemical, Biological, Mechanical and Radiation hazards

Introduction

Emergency is defined as a serious, unexpected, and often dangerous situation requiring immediate action (Oxford Dictionary). Another definition stated in UK Civil Contingencies Act, 2004 focused on accident as an event or situation that threatens serious damage to health, life, property, or environment. It added war and terrorism to the definition as they threaten serious damage to security.

Disaster is a disruption of the human ecology that exceeds the capacity of the community to function normally. Disasters can be classified by cause into:

1. Natural disasters including weather-related events such as hurricanes, tornadoes, heat waves, wild fires, cold environments and floods and geological or geographical events as earthquakes and volcanic eruptions.
2. Human-made causes defined as non-natural or technological disasters,

either caused by accidental or deliberate human action. The worst non-natural disasters resulting in human suffering and death have been caused by wars, transport and industrial activities. Industrial disasters led to serious danger even to people outside work areas, and to the general environment. They are uncontrolled events involving fires, explosions, releases of toxic substances or exposure to radioactive sources (Bertazzi, 1998). They also involve disease outbreaks, and workplace violence resulting in bodily harm and trauma (OSHA, 2001).

A workplace emergency is an unforeseen situation that threatens workers, customers, or the public; disrupts or shuts down operations; or causes physical or environmental damage. Emergencies may be natural or man-made.

Emergencies in occupational environment include:

- Fire and explosion
- Chemical accidents (as toxic gas release and chemical spill or leak)
- Physical accidents (including radiological and nuclear accidents and electrical accidents)
- Biological exposures
- Mechanical accidents
- Psychosocial exposures (as violence at workplace)

I. Fire and explosion

Fire is a manifestation of uncontrolled combustion, while an explosion is characterized by the sudden release of energy, producing a shock wave, or blast wave, that may be capable of causing remote damage (Grant, 1998). In the UK each year there are around 25,000 non-residential fires reported, with a significant proportion of these fires occurring in the workplace.

Common fire hazards in the workplace include: waste and combustible material being stored in unsuitable place, flammable liquids, vapours, and substances, dust build-up from wood, plastic and metal operations, faulty electrical equipment which is one of the most common types of fire in the workplace, overloading power sockets,

smoking and discarded cigarettes, in addition to human error and negligence.

Fire triangle is used to show the three elements that when present together can cause a fire to start. These are fuel, heat and oxygen. They should be kept apart to avoid a fire starting and one of them has to be removed to stop the spread of a fire (Euro fire protection, 2013).

Fire prevention plan was specified by OSHA (Occupational Safety and Health Administration) (2004) as a general requirement for emergency preparedness; it requires identification of the flammable and combustible materials stored in the workplace and ways to control workplace fire hazards.

Examples of some fire and explosion disasters

-In October 25, 2017, an accidental ignition of stored fireworks in a manufacturing factory in Kosambi, Tangerang, Indonesia took place. The explosion occurred in a warehouse connected to the factory and ignited a massive fire. At least 49 people were killed and 46 were injured in the incident out of 103 ones. It was suggested that an accidental ignition of gunpowder caused the blast and fire (Wikipedia, 2017).

-In August 12, 2015, two explosions occurred at a container storage station at the port of Tianjin in the Binhai New Area of Tianjin, China resulting in death of 173 individual (Jacobs, 2015).

- In October 29, 2012, Hurricane Sandy caused a Con Edison power plant to explode. This resulted in a blackout in most of midtown Manhattan to the extent that the blue light emitted from the arc made places glow as far as Brooklyn. No person was killed or injured (Wikipedia, 2017).

II. Chemical accidents

A-Toxic gas release

Gases can be flammable and explosive, toxic, and asphyxiating. The risks of compressed gases in gas cylinders include: the risks of hazardous properties of the gas itself, risks from a leak e.g. physical injuries due to high pressure and/or extremely low temperature of the escaping gas, and accidents from improper use and transport of gas cylinders. The uses of compressed gases are various as in: chemical processes, welding and flame cutting, breathing (e.g. diving, emergency rescue), medical and laboratory uses, dispensing beverages,

fuel for vehicles (e.g. fork-lift trucks), extinguishing fires, heating and cooking, and water treatment (Turkdogan and Mathisen, 1998).

Chemical asphyxiants that may lead to emergency situations in the occupational environment include :

- 1- **Carbon monoxide (CO):** Concentrations of carbon monoxide build up when a combustion engine is run inside a structure (such as a car in a garage, a gasoline-powered pressure washer in a barn, or a propane forklift in a warehouse), when a furnace is improperly vented, or when combustion is out of control, as with a fire. Transportation vehicles and power plants are the major ambient air sources (Rosenman, 2007).
- 2 - **Hydrogen Cyanide (HCN):** Firefighters are frequently exposed by inhaling smoke from pyrolysis products of synthetic materials.
- 3- **Hydrogen Sulfide (H₂S):** Fatal exposures occur in the workplace of many industries including petroleum and natural gas extraction and processing, underground coal mines, livestock raising during the agitation of manure in storage

and treatment, and sewers and human sewage treatment facilities (known as sewer gas). It may be found environmentally in natural gas deposits and volcanic gases (Beckett, 2007).

Emerging risks arising from gases in new technologies include: development of newer energy sources as the use of biomass and production of biofuels by fermentation or chemical extraction, release of inorganic and organic gases from recycling materials, increase use of polymer composites and their decomposition in fires generating a complex mixture of hazardous gases (e.g. isocyanates, styrene), use of inert gases in reducing the oxygen concentration for fire suppression, and use of oxygen therapy for patients at home (Walsh, 2016).

Confined spaces

They are substantially (though not always entirely) enclosed with specified risk which means a risk of serious injury to any person at work arising from a fire or explosion, or asphyxiation due to gas inhalation and oxygen deficiency. The risk can be increased due to some occupational activities as welding that would consume some of the oxygen, a spray booth during paint spraying, or

using chemicals for cleaning purposes which can add contaminants.

No one should enter or work in a confined space unless there are emergency arrangements in place that are appropriate for the level of risk involved in the task/space (HSE, 2014).

There are some specific requirements for permit-required confined spaces (PRCS), determined by OSHA (2004) as a part of emergency preparedness, including establishment of rescue, and emergency procedures.

B-Chemical spill or leak

Emergency Response Operations are applied for the release of, or substantial release of, hazardous substances e.g. Response to: the spill of a highly toxic substance, the leaking storage tank, overturned truck carrying hazardous materials, and chemical fire (Gochfeld, 2005). So, the presence of material safety data sheets (MSDSs) for each chemical is a must.

As regards pesticides, organophosphate, particularly Leptophos was the cause of death of several farmers, and buffalos in Gharbia Governorate, Egypt. Accidental deaths were also recorded with the agricultural use of Methomyl (Lannate) which

is an acutely toxic carbamate. The use of pesticides in Egypt reached its maximum with many deaths in 1971 (Emara and Zayet, 2011).

Chemical exposure to the eye is an **ocular emergency**. Chemicals may be splashed or sprayed into the eyes whether acidic or alkaline causing corneal burns, however alkali burns are an ophthalmic emergency which may penetrate all the layers of the eye (Smedley et al., 2007).

Examples of some chemical disasters

- **Bhopal disaster** in central India represents the worst chemical industrial disaster ever. It occurred in December 3, 1984 where a runaway exothermic reaction in a tank containing poisonous methyl isocyanate caused the pressure relief system to vent large amounts to the atmosphere. The result is death of thousands and injury of hundreds of thousands in few hours in addition to the possible long-term consequences in the survivors after Bhopal gas tragedy (Bhargava et al., 2010). This was due to the toxic gas leak from a pesticide plant which formed a deadly cloud spreading over the city of Bhopal (Havens et al., 2012).

-In July 6, 2013 in Lac-Mégantic,

Quebec Canada, forty-seven people were killed when there was a derailment of an **oil shipment train**. The oil shipment caught fire and exploded, destroying more than thirty buildings. It was the fourth-deadliest rail accident in Canadian history (Wikipedia, 2017).

III. Physical exposure

A. Radiation and nuclear accidents

Radiation emergencies may be intentional (e.g., caused by terrorists) or unintentional.

Accidents can occur if: radiation sources are stored or used improperly, safety controls are not proper, or safety procedures are not followed.

Health effects degree depends on the type and amount of radioactive material, how long people were near the radioactive material or how long the radioactive material was in or on the body, how close people were to the radioactive material, and what parts of the body were exposed. Protection from health effects of radiation accidents needs that workers should be familiar with safety precautions and procedures, they should stay as far away from the site of the accident as possible, and they have to listen for instructions from safety officials (CDC, 2014).

Examples of some radiation and nuclear industrial disasters

The worst type of nuclear accidents is the **nuclear meltdown** which is a severe nuclear reactor accident that results in reactor core damage from overheating.

- **The Fukushima I nuclear disaster** following the earthquake and Tsunami in Japan, March 2011 is regarded as the largest nuclear disaster since the Chernobyl disaster. There were no direct deaths but a few of the plant's workers were severely injured or killed by the disaster conditions resulting from the earthquake. Fukushima coast transported the contaminated waters far into the Pacific Ocean, thus causing great dispersion of the radioactive elements. Despite cesium isotopic concentrations in the waters off of Japan being 10 to 1000 times above the normal concentrations prior to the accident, radiation risks are below what is generally considered harmful to marine animals and human consumers (Buesseler et al., 2012)

- **The Chernobyl disaster** at Chernobyl Nuclear Power Plant took place in Prypiat, Ukraine, USSR, in April 26, 1986. It occurred as a test on reactor number four which went out of

control, resulting in a nuclear meltdown. The ensuing steam explosion and fire killed up to 50 people with estimates that there may be between 4,000 and several hundred thousand additional cancer deaths over time. Fallout could be detected as far away as Canada. The Chernobyl Exclusion Zone, covering portions of Belarus and Ukraine surrounding Prypiat, remains contaminated and mostly uninhabited. Prypiat itself was totally evacuated and remains as a ghost town (UNSCEAR, 2017).

B. Electrical accidents

Exposure to electric current remained the seventh on the list of occupational exposures leading to fatal on-the-job injury. Electrocutions constituted the vast majority of electrical fatalities while electrical burns of all degrees were responsible for some fatalities. Most of all fatal electrical injuries occurred in mining, construction, and manufacturing industries. This is according to statistics on workplace electrical fatalities and injuries made by Electrical Safety Foundation International (ESFI) in the period between year 2003 -2015 (ESFI, 2017). Most on-the-job electrocutions and electrical injuries can be prevented.

IV. Biological exposures

One of the emergency situations in the workplace due to biohazards is snakebites and scorpion stings. If venomous snakebites are suspected in the workplace, workers should wear foot and leg protection and be provided with monovalent or polyvalent antivenom serum.

Those who provide emergency and security services are at a risk of infectious disease exposure. Exposure occurs through skin whether intact or not, needle sticks, eye splashes or mucous membrane. Needle stick injuries (NSI) and contamination incidents carry the danger blood-borne infection. Infectious disease education programs and hepatitis B vaccination are mandatory for all healthcare personnel (Fakhri, 1998).

Emergency procedures, for those working in **microbiological laboratories**, should be taken in the following situations: puncture wounds, cuts and abrasions, ingestion of potentially infectious material, potentially infectious aerosol release (outside a biological safety cabinet), broken containers and spilled infectious substances, breakage of tubes containing potentially infectious material in

centrifuges not having sealable buckets, breakage of tubes inside sealable buckets (safety cups), in addition to fires and natural disasters (WHO, 2004).

Outbreaks of infectious diseases

Proper disaster planning should be considered to limit the spread of an infectious outbreak that potentially would paralyze even larger medical facilities. All members of medical staff should be trained on higher levels of respiratory protection in order to respond to the needs of such an outbreak (Takahashi and Fujimoto, 2007).

V. Mechanical accidents

Injuries are a leading cause of work-related morbidity and mortality among those in the labor force. Occupational fatalities differ according to the occupation. The highest rates are found in the agriculture, mining, construction, and transportation industries. The use of a scientific approach for development of interventions is mandatory for occupational injury control. Injuries are viewed as preventable problems (Alexander and Rivara, 2005).

Occupational Ocular emergencies due to mechanical causes include: accident-related ocular trauma, and corneal foreign bodies are mostly

the result of occupational accidents in workers not wearing protective goggles as reported by an Egyptian study at Cairo University Hospitals (El-Mekawey et al., 2011).

VI. Psychosocial exposures

Violence is an extreme form of aggression. Violence can be a source of emergency in the workplace which may lead to post-traumatic stress disorder that needs trauma intervention.

Post-traumatic stress disorder (PTSD)

Post-traumatic stress disorder (PTSD) is a specific psychological syndrome that may develop after major disasters and instances of violent assault, not only in those directly involved in the incident but also in those who have witnessed it (Warshaw, 1998).

The occurrence of PTSD has been reported in accident victims, flight attendants, firefighters involved in World Trade Center rescue after 11th September in 2003, and in security personnel (Lating et al., 2004).

Trauma intervention

Workplace events that represent a recognizable threat to physical integrity may result in vulnerability

to developing symptoms of an acute stress syndrome among employees. A psychoeducational intervention by a trauma expert is needed to deal with the aftereffects in the work group (Larsen, 2007).

Terrorism

Terrorism may involve the deliberate use of chemical, biological, radiation or nuclear weapons (CBRN). Radiation and chemical agents can enter the body by inhalation, absorption through skin or eyes, injection by flying glass or shrapnel, and ingestion, while biological agents are usually transmitted through inhalation (Smedley et al., 2007).

Emergency workers

Emergency workers are personnel who work in emergency response situations protecting human life, property and the environment during accidents, major incidents and disasters. They are also called “emergency responders” or “first responders”. They include firefighters, police officers and military personnel, and paramedical and rescue personnel.

They are potentially exposed to common **Occupational Hazards** which could be

-Psychogenic stress and stress-

related outcomes including PTSD.

-Exposure to infection with communicable diseases as a biological hazard. The common serious infections include: HIV infection, hepatitis B and C and tuberculosis.

-Different injuries arising from fires, violence, mechanical factors or hazardous chemicals (Guidotti, 1998).

In addition to the basic qualification requirements including personal qualities (as having good communication skills and enough courage to face emergency situations) and educational requirements, they have to receive regular training, theoretical and practical on their basic physical, psychological, and managerial work demands essential for job performance.

Emergency Response and Preparedness

The best way is to prepare for response to an emergency is before it happens, as clear and logic thinking during a crisis is difficult (OSHA, 2001). The worst scenario should be expected.

Steps for developing an **Emergency Action Plan (EAP)**:

A- Identification and assessment of potential emergency situations in the

work environment, determination of emergency preparedness needs.

B- Identification of ways to plan for these situations.

C- Development of a plan:

- Establish an emergency response team with well-defined roles and responsibilities
- Obtain input from managers, workers, and Occupational Health and Safety committee
- Identify roles of all workplace parties, including essential staff such as maintenance and security workers, human resources personnel and senior managers
- Coordinate plan with external resources such as the police, hospitals and utilities
- Provide emergency response training
- Identify and post evacuation routes
- Purchase emergency response equipment
- Post names of workers trained in First Aid
- Post emergency phone numbers

- Develop internal and external communication plans
- Conduct drills and exercises
- Plan for clean up, recovery, or salvage

D- Development of general procedures as well as procedures specific to each emergency situation.

E- Reviewing and updating of the plan regularly based on feedback from the drills as well as changes in personnel, the work environment, work procedures, tools and equipment (WHSCC, 2016)

There is a great influence of training on the workers' behavior, and consequently on their evacuation time, in case of an emergency (Miguel et al., 2010).

The requirements for emergency preparedness as specified by OSHA-Occupational Safety and Health Administration (2004) are categorized into:

I. General requirements starting from exit routes design and maintenance, in addition to medical services and first aid, portable fire extinguishers, and ending by employee alarm systems for emergency action or safe evacuation.

II. Additional requirements for specific workplaces include personal protective equipment (PPE), respiratory protection, air contaminants mitigation, bloodborne pathogens control, and hazard communication.

Situation in Egypt

1- Common accidents and emergencies

- In Alexandria, a chemical accident was recorded at a factory for chlorine gas production. In December 21, 1987, an explosion occurred in the factory with a release of huge amount of chlorine gas resulting in 8 deaths and 142 injuries (UNEP, 1999).
- Leakage of chlorine gas at a chemical factory in 6thOctober City due to poor storage of chlorine gas cylinders.
- Leakage of ammonia gas at a petroleum company in Alexandria due to system failure
- Many of chemical accidents in Egypt are associated with tankers carrying petroleum products, concentrated acids and chlorine (ENCPC, 2011). Surprisingly, about 50% of acute disasters are due to unplanned transportation of chemicals (Emara

and Zayet, 2011).

-Fire and explosion accidents occurred before year 2011 in Egypt include: (ENCPC, 2011)

i - A large fire and explosion in butane tank at a petroleum company in Suez. Some workers saw a car burning shortly before the explosion

ii - A fire in the production area at paints factory in 6th of October city due to human error in the alkyl resin

iii - An explosion in the storage area at paints factory in Port Said due to storage of nitrocellulose in an open exposed directly to sun

Many industrial accidents are not reported to the authorities, especially in small and medium enterprises. The under reporting could be due to lack of adequate chemical safety practices and lack of information on the types, quantities and application of chemical wastes in Egypt.

• **Accident Prevention and Preparedness in Egypt**

Egypt National Cleaner Production Center (ENCPC) discussed Egyptian efforts to improve Accident Prevention and Preparedness at different levels and submitted it to UNEP, focusing

on SMEs (small and medium sized enterprises) in Egypt:

1. Existing Programs and Projects on Accident Prevention such as: The Cleaner Production Program, Intergovernmental Forum on Chemical Safety (IFCS), and Safety in the Use of Chemicals at Work.

In addition to that, Egypt has participated in some international agreements/procedures related to environmental protection such as that concerned with nuclear energy and hazardous substances and waste.

2. Human Resources for Accident Prevention which can be done in 2 levels:
 - i -Industrial level: The facility is responsible for increasing awareness of the employees, and for maintaining and updating the emergency action plan (EAP).
 - ii –Governmental level: It is represented in the Civil Defense that is affiliated to the Ministry of Interior. It is responsible for monitoring and inspecting the implementation the EAP in the facilities.

3. Financial Allocation from the National Budget

Some Egyptian institutions or agencies have specific limited budget lines for accident preparedness which are allocated to meet the need of the post incident impacts.

These institutions include: the Ministry of Social Solidarity, the Egyptian Environmental Affairs Agency (EEAA), the Ministry of Health and Population (MOHP) which has an annual budget for disaster risk reduction, and Civil Protection Authority (CPA) that has similar budget.

The different levels of accident prevention and preparedness

1. There is no common plan of inspection for accident prevention and preparedness in Egypt. The responsibility of inspection is divided between many ministries.
2. There are different policies and strategies to promote industrial safety in general and including the accident prevention, but still in need to harmonize and synergize all of these to specifically promote industrial accident prevention.
3. Some Egyptian laws, codes and article to enforce and promote

accident prevention, some of them concerns with hazardous substances and management of hazardous wastes.

4. Many stakeholders are concerned with accident prevention and preparedness in Egypt but still lacking cooperation and synergies especially in developing national plan for accident prevention and preparedness, and in development of common and available data-base for accidents in Egypt, its reasons and measures taken to avoid it.
5. There are trials of raising awareness on accident prevention and preparedness in Egypt, but this needs to be disseminated and up-scaled on national level (ENCPC, 2011).

Conclusion

As a conclusion, emergency in occupational environment is a situation that causes physical damage (physical loss of souls and possessions). Emergency action plan should be based on the nature of the workplace and its surroundings, and the potential emergency situations in the work environment.

The responsibility for accident

prevention and preparedness is divided between different ministries and organizations with no common inspection plan and there is lack of coordination between them. There is no adequate national plan to manage the accident prevention and preparedness in appropriate way especially for small and medium sized enterprises in Egypt.

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