

## Industrial Accidents- Medicolegal Issues Reviewed

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### Abstract:

Mapping Industrial Disasters, & relevant laws, based on the past incidences becomes relevant. The goal of the initiative is to prioritize prevention for further in-depth legal investigation & evaluation. We have mapped these to identify their pattern of man-made disaster in the environment, in their region of production, casualty and sickness, and further prevention of such as disaster-associated morbidity & mortality in community, leading to mass casualties, since the time immemorial. The legal know-how of regulations can aid the healthcare providers, in proper medicolegal documentation, in best interests of the victims.

**Keywords:** Industrial Disaster; Accidents; Sabotage; Arson; Laws, Regulations.

### Introduction

Medicolegal investigation has been performed for centuries in all societies, although not always by medical professionals.

Industrial accident means an event resulting from the uncontrolled development in the course of any activity involving hazardous substances either in an installation, for example during the manufacture, use, storage, handling, or disposal; or during transportation.<sup>1</sup>

The term accident for the purpose of the law relating to compensation for the personal injuries sustained

by the workmen & the employer liability in that behalf includes any injury which is not designed by the workmen himself, and it is of no consequence that the injury was designed and intended by the person inflicting the same.<sup>2</sup>

All I's for Easy Recall Identify & investigate an I-Industrial Accident

How to I-#Identify common toxic xenobiotics

How to I-#Investigate a case of Disaster

How to I-#Interpret the findings in scene of accident

How to I-#Interrogate the victim/ accused of accident

How to I-#Initiate the criminal proceeding

How to I-#Intervene the dying victim by first aid as scene of crime

How not to I-#Incite" Nor "I-#Instigate" unnecessarily at scene of accident

### Discussion

Mass casualties in industrial accidents can be due to building collapse, fire, chemical burns, electrical sparking, electrocution, explosion, earthquake, leakage of toxic gas, toxic spill.

- Interrogation / Interview Techniques
- Medical Forensics
- Equipment Failure Analysis
- Chemical & Toxic Investigations
- Blast & Explosive Investigations

A good investigator collects evidence, analyzes them, finds the root causes and the relations among

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these causes that lead to the accident and provides suggestions about corrective actions to avoid the reoccurrence of the undesired event.

#### Science of Investigation

- Evolution of Forensic Science
- Principles of Forensic Science in Investigating Industrial Accident
- Theories on Causes of Accidents (with examples & case studies)
- Swiss Cheese, Heinrich and other models
- Root Cause Analysis
- Fishbone Analysis and other tools
- Importance of Reconstruction of Accident
- Recommending Corrective Measures

#### How to Investigate Industrial Accident

- Evaluate internal and investigation reports, witness statements, documentation and photographs;
- Conduct site inspection and evaluation;
- Collection of physical evidence;
- Examine damaged materials, transferred evidence, conduct chemical analysis to identify chemicals, perform simulation experiments to investigate the reactions and compatibility of chemicals;
- Evaluate industrial processes, work practices, systemic vulnerabilities, and review safety protocols and compliance of practices with best practice;
- Determine the mechanism and function of equipment, as well as the properties of materials; and
- Reconstructing the sequence of events and the possible actions of persons involved in the incident.

How to take History in Industrial Disaster? All K's for easy recall

- K- Kya Hua (Accident/ Arson/ sabotage)
- K- kab Hua (Day, Date, Time of the incidence)
- K- Kaunhai victim (Name, age, gender)
- K- Kahan (place)
- K- Kitne persons(mass Casualty)
- How to take History in Toxic Disaster
- K- Kya khaya (than call Poison control centre)
- K- KitnaKhaya (fatal dose)

- K- KabKhaya (fatal period)
- K- Kesekhaya =ingestion/ inhalation/ injection
- K- Kyunkhaya (Intention-accidental / homicidal/ suicidal reattempt)

The police may book company's Chairman, Director, Plant Manager, Operator and Supervisor) in the FIR under various IPC sections for any industrial disaster:

- 304 (Punishment for culpable homicide not amounting to murder),
- 338 (Causing grievous hurt by act endangering life or personal safety of others),
- 337 (Causing hurt by act endangering life or personal safety of others) and
- 114 (Abettor present when offence is committed).

Medicolegal Reports (MLR) are documents prepared by RMP's government & private doctors, pertaining to injury, sexual offence, suspected poisoning or unexplained death in industrial workers. It contains all the facts, observed by the doctor & his opinion drawn therefrom. Doctor's opinion must be based upon the clinical observations made by him, & not on hearsay evidence.

#### Examples of Medicolegal Case (MLC) for industrial injuries:-

- Injuries can be physical/chemical/ thermal/ electrical
- Fall from Height
- Crush injury of limbs caught in machine
- Mass food poisoning in eatables.
- Attempted suicide
- Brought Dead
- Alcohol Intoxication
- Chemical injuries, Burns and Scalds
- Venomous Animal Bites- snake, scorpion
- Drowning
- Electrocution

By our nature's gift of 5 senses on scene of accident:

- see 👁 (with safe distance),
- touch (texture, feel with safety),
- smell 👃 (with precautions),
- taste 👅 (not advised, better test it),
- hear 👂 the dying declaration, death rattle, sounds in dying 👁 victims

Whether act was Accidental or Intentional:

Arson as a crime can be defined as wilful and maliciously setting fire to a property to cause damage.

Section 435 of IPC states that "Whoever commits mischief by fire or any explosive substance intending to cause, or knowing it to be likely that he will thereby cause, damage to any property to the amount of one hundred rupees or upwards".<sup>3</sup>

If the injury or death from the point of view of the workmen who dies or suffers the injury, is unexpected or without design on his part, then the death or injury would be accident although it was brought about by a heart attack or some other cause to be found in the condition of the workmen himself.<sup>4</sup>

#### *Criminal Intentions of the Industrial Accidents:*

- False Insurance Claim for unlawful pecuniary gain.
- Destruction of evidence of crimes of fraud, theft or murder to look as accident.
- Pyromania – mental disease of fascination of igniting fire.
- Fire of revenge by an employee with grievance
- Illicit manufacture of illegal material- liquor, narcotics or banned drugs, smuggled goods.

The following acts and rules lay down requirements for emergency preparedness and payment of relief and compensation in India.

- The Factories Act, 1948, amended in 1976 and 1987.
- The Environment (Protection) Act, 1986.
- The Public Liability Insurance Act, 1991, amended in 1992.
- Fatal Accidents Act, 1887
- Workmen Compensation Act, 1923
- Bhopal Gas Leak Disaster (Processing of Claims) Act 1985
- Law of Tort
- Personal Injury law
- Arson Law

#### ☑Golden Rule of Industrial Disaster Investigations

- Prioritizing your 5 Senses (☑, ☑, ☑, ☑, ☑)
- which to use best, and which to utilize least:-
- Use your eyes the most (observe more),

- hands the less (disturb and contaminate to lesser extent) and
- Mouth the least (first analyze the facts then opine,) and
- never disclose to media, always disclose to the legal authority with proper reasoning & scientific logic),
- never taste ☑the toxin to find what it is☑(as its shown wrongly in our movies & serials) Better get it tested in chemical laboratory (Test, not taste)

#### *Heinrich theory for accident prevention:*

The relationship was first proposed in 1931 by Herbert William Heinrich in his Industrial Accident Prevention: A Scientific Approach. Heinrich was a pioneer in the field of workplace health and safety. Heinrich's theory suggested that 88% of all accidents were caused by a human decision to carry out an unsafe act.

#### *Accident causation: Swiss cheese model*

The Swiss cheese model of accident causation is a model used in risk analysis and risk management, including aviation safety, engineering, healthcare, emergency service organizations, and as the principle behind layered security, as used in computer security and defense in depth.

It likens human systems to multiple slices of swiss cheese, stacked side by side, in which the risk of a threat becoming a reality is mitigated by the differing layers and types of defenses which are "layered" behind each other.

Therefore, in theory, lapses and weaknesses in one defense do not allow a risk to materialize, since other defenses also exist, to prevent a single point of failure.

It is sometimes called the "cumulative act effect".

In the Swiss cheese model, an organisation's defenses against failure are modeled as a series of barriers, represented as slices of cheese.

The holes in the slices represent weaknesses in individual parts of the system and are continually varying in size and position across the slices.

The system produces failures when a hole in each slice momentarily aligns, permitting "a trajectory of accident opportunity", so that a hazard passes through holes in all of the slices, leading to a failure.

A fire hazard is a situation in which there is a greater than normal risk of harm to people or

property Fire hazards are caused due to materials which catch fire easily and produce toxic fumes when heated or objects which block fire exits, such as blocked cooling vents, or overloaded electric systems and threat hazard to people. Fire due to equipment, LPG, oxy acetylene, oxygen, hydrogen and other inflammable cylinders' explosions. Burst of boilers or containers filled with molten metal. Fire can spread rapidly in insufficiently protected fuel stores or areas with high oxygen concentrations.

### ***Food industry related toxicology***

*Adulteration with low-cost material, Contamination with infectious bacterial & algal toxins, carcinogenic chemicals for preservation & colouring agents, mass food poisoning; Mid-Day Meals*

### ***Mining industry related toxicology:***

*Occupational Hazards-Asbestosis, Silicosis, Restrictive lung disease, Lung Cancer. Metal fume fever- smelters*

### ***Energy industry related toxicology:***

*Lithium toxicity - Mobile Battery, Lead toxicity- Vehicle batteries, Radioactive metal exposure in thermal power plants- Chernobyl disaster.*

The Chernobyl disaster occurred on April 1986 at V.I.Lenin nuclear power plant with four 1000 reactors constructed to a flawed design that was operated by poorly trained personnel.<sup>31</sup> workers died due to radiation poisoning and 30 km evacuation zone created. People were exposed to 1000 times more than the normal radiation. The long term affects resulted in fatal accident.<sup>5</sup>

### ***Manufacturing industry related toxicology:***

*Toxic Gas exposure- Methyl Isocyanate (MIC) - Bhopal Gas Tragedy in Pesticide manufacturing plants, Water pollution due to toxic chemical release in waste disposal, Cyanide gas in wool processing & plastic manufacture*

Highlighted Points in Tyagarajan's Report on Bhopal Gas Tragedy for Legal Responsibility:

- There were cracks in the leaked tank and about 30% more of liquefied MIC than permitted was stored.
- Another tank was found with 35 ton of MIC with similar risk was neutralised deploying helicopter with water jets and area was covered

to arrest any leakage of gas or escape for which production plant was started to produce pesticide.

- Clogged pipes were with rusted joints
- It was a disaster of low possibility with high consequence.
- Anderson, the than CEO claimed that it was a sabotage.
- Nitrogen layer was protective layer on top of MIC stored.
- Cooling systems failed.<sup>6</sup>

The tragedy of Bhopal continues to be a warning sign at once ignored and heeded. Bhopal and its aftermath were a warning that the path to industrialization, for developing countries in general and India in particular, is fraught with human, environmental and economic perils.<sup>7</sup>

Michel Wright Investigator From Usa Investigation on Negligence:

- Vent gas scrubber unit was not sufficient to neutralise Leaked MIC
- Pressure gauzes were faulty
- No refrigeration system was available
- Leakage caused due to cracks in the MIC storage tank
- Water canons to neutralise MIC was not sufficient
- Negligence on part of management was found.
- The plant ought to have been closed well in advance to avert disaster.<sup>8</sup>

The company involved in what became the worst industrial accident in history immediately tried to dissociate itself from legal responsibility. Eventually it reached a settlement with the Indian Government through mediation of that country's Supreme Court and accepted moral responsibility.<sup>9</sup> It paid \$470 million in compensation, a relatively small amount of based on significant underestimations of the long-term health consequences of exposure and the number of people exposed.<sup>10</sup> The disaster indicated a need for enforceable international standards for environmental safety, preventative strategies to avoid similar accidents and industrial disaster preparedness.<sup>11,12,13</sup>

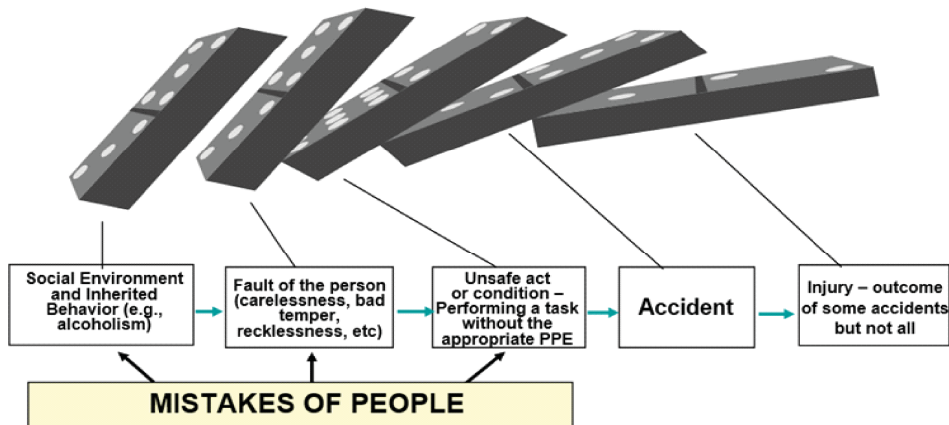
A leak from a styrene tank at a polystyrene plant in Visakhapatnam, India, has killed at least 13 people and injured hundreds. Local reports say between 300 and 400 people have been taken to the hospital with breathing difficulties and a burning sensation in their eyes.<sup>14</sup>

Mapping Atlas of Toxic Disasters around the Globe Indian Society of Toxicology Department of Emergency, Medanta Medicity, Gurugram

North West (Europe)	North (Ukraine-Russia- Siberia)	North East (China, North Korea)
<ul style="list-style-type: none"> <li>Jewish German Holocaust- Cyanide Gas</li> <li>Toxic chemical spill (Switzerland)</li> <li>Rhine Red, Fish Dead (organophosphate insecticides, mercury compounds &amp; Organochlorines)</li> <li>Notre Dame Holy water poisoning in Paris</li> <li>Dioxin- Seveso industrial disaster-Italy</li> <li>Huelva mines- Metal fume toxicity in Riotinto</li> </ul>	<ul style="list-style-type: none"> <li>Chernobyl Nuclear Disaster - Ukraine radioactive metal toxicity</li> <li>Rum Whiskey intoxication</li> <li>Rasputin Execution failed-Cyanide laced Rum-Cake</li> </ul>	<ul style="list-style-type: none"> <li>Opium-silk route (Golden Triangle)</li> <li>Baotou toxic lake: man-made lake of toxic waste</li> <li>Toxic air tears apart families in Mongolia</li> <li>A toxic warning to the world: the traditional tents –known as GERS –are warmed by coal-Coal Gas</li> <li>Jilin chemical plant- Hydrocarbon exposure</li> </ul>
West (North America - USA, Mexico, Canada)	Central (Middle East,Africa-Arabia-UAE)	East (South Korea Japan)
<ul style="list-style-type: none"> <li>Battery lead contamination-Industrial Lead toxicity in Los Angeles, California</li> <li>Greenpoint Oil Spill - Brooklyn, New York</li> <li>Toxic Potato Salad (Ohio)- Large outbreak of botulism associated with a church potluck</li> <li>Bitter Coffee at Church Breakfast- Cyanide Tragedy</li> <li>United States of Toxins- Utah &amp; Nevada- metal mining- metal fume toxicity</li> <li>Iatrogenic Opioid Epidemic</li> </ul>	<ul style="list-style-type: none"> <li>Mad-Honey, bee &amp; wasp stings</li> <li>Cantharides</li> <li>Golden Crescent- Opium (Afghanistan-Iran-Pakistan)</li> <li>Carbon monoxide - Gas Heaters</li> <li>Apricot- Cyanide1</li> </ul>	<ul style="list-style-type: none"> <li>Red-tide + Harmful algal bloom in sea coast in summers</li> <li>Seafood poisoning - Fugu, Ciguatera</li> <li>Sarin (OPC) Tokyo Subway - Bioterrorism (641 victims)<sup>15</sup></li> <li>Fukushima Daiichi nuclear disaster</li> <li>Cadmium toxicity - Itai-itai disease- "it hurts-it hurts disease" Jinzu river basin-Toyama Prefecture, Japan</li> <li>Methyl mercury- Minamata disease</li> <li>Hiroshima Nagasaki Nuclear Attack &amp; resulting toxicity in Japan</li> <li>Hydrofluoric acid leak- South Korea- toxic hydrogen fluoride (HF) gas</li> </ul>
South West (South America, Brazil, Peru, West Indies)	South (Australia, South Africa)	South East (Asia -India- Malaysia, Cambodia, Thailand, srilanka)
<ul style="list-style-type: none"> <li>Black widow Spider</li> <li>Black scorpion</li> <li>People's temple massacre -Cyanide laced drinks<sup>1</sup></li> <li>Toxic mud into the Doce River- Heavy Metal Mining; Mariana, Brazil</li> <li>Goiania radioactive toxicity due to dismantling a scrapped radiotherapy machine in Brazil</li> <li>UCLA Laboratory Fire- tert-butyl lithium</li> <li>IHOP Restaurant - Chloramine gas toxicity- kitchen employee -dishwashing machine (South</li> <li>Charleston, West Virginia)</li> </ul>	<ul style="list-style-type: none"> <li>Rattle Snake &amp; Coral Snake</li> <li>Ivory Coast toxic waste dumped of toxic oil sludge</li> <li>Esperance's lead poisoning disaster</li> <li>Agent Orange is a herbicide and defoliant chemical, one of the "tactical use" Rainbow Herbicides- Vietnam War- Bioterrorism</li> <li>Phosphate toxicity mining in Nauru</li> </ul>	<ul style="list-style-type: none"> <li>Opium (Golden triangle) India-China- Malaysia- Thailand</li> <li>East India: toxic runoff of Arsenic, Pesticides</li> <li>Decline of vultures - toxic scavengers - Diclofenac toxicity</li> <li>Western Ghats- Red scorpion</li> <li>HOOCH Tragedy- Methanol Country Liquor- Malaysia, India</li> <li>Methyl IsoCyanate (MIC) Bhopal Gas Tragedy- World's Worst Industrial Disaster</li> <li>Cyanide Rash- Cassava tubers, Tapioca</li> <li>Karnataka-Pesticide casualty - Holy Prasad</li> <li>Carbon monoxide epidemic-Sigdi, Kangri Gas Geysers</li> <li>Sewer Gas tragedy- Manhole- Hydrogen sulphide</li> </ul>

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## 1932 First Scientific Approach to Accident/Prevention - H.W. Heinrich



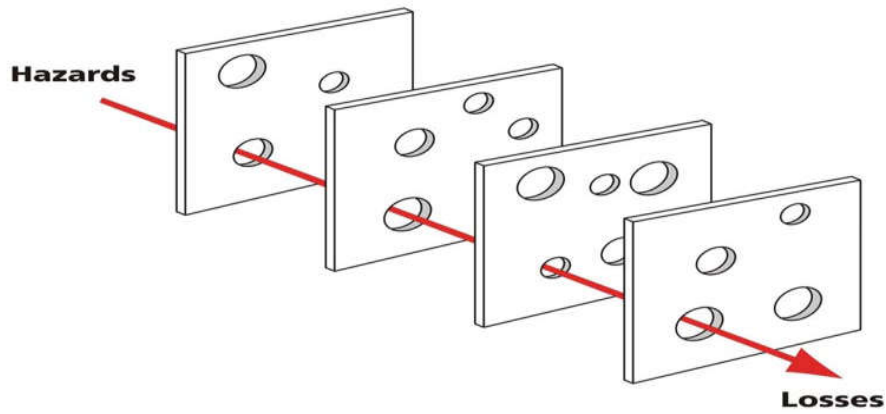
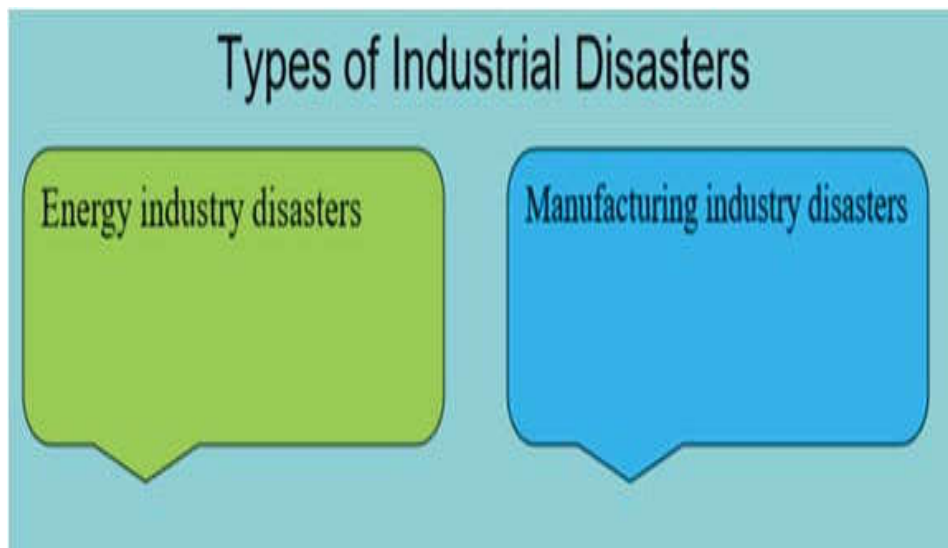
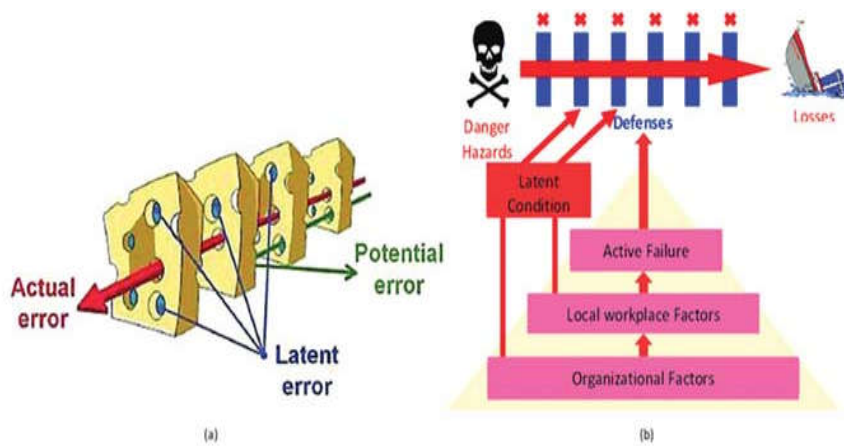
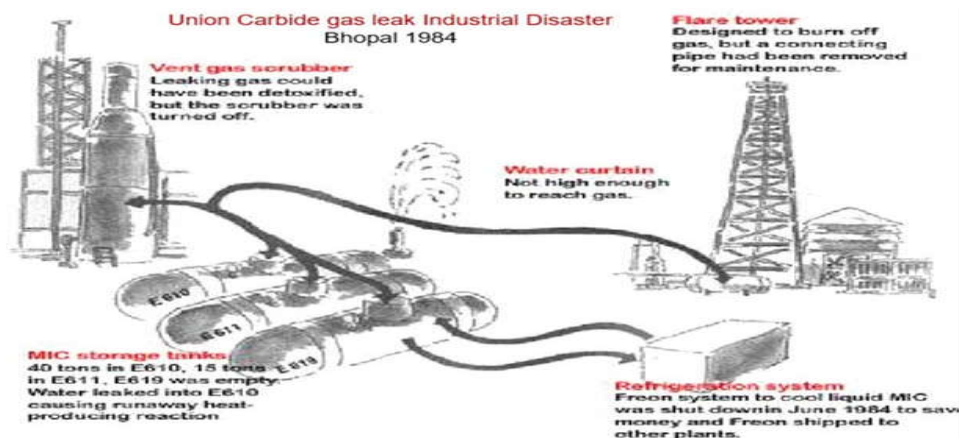


Fig. 1. The Swiss cheese model of accident causation illustrates that, although many layers of defense lie between hazards and accidents, there are flaws in each layer that, if aligned, can allow the accident to occur.





### Key components in the Chain of Survival in Industrial Emergencies and Disasters.

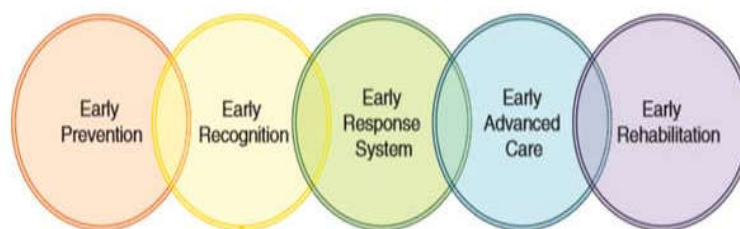


Fig. 2. Chain of Survival in Industrial Emergencies and Industrial Disasters<sup>17</sup>

PPE (\*Personal-Protective-Equipment\*) for HAZMAT Team handling victims:

HAZMAT- stands for HAZardousMATERial: radiotoxic solids/liquids/Gas

- A-Aprons of Lead
- A-Air Purifying Respirator(APR)
- B- Breathing Apparatus
- B- Booties of Rubber/Leather upto the knees
- B- Biohazard bags with International Biohazard Sign for collecting samples/ disposing the contaminated clothes/ liquids.
- B-Barrier creams - toothpaste applied around eyelids
- C- Caps of plastic for Head
- C-Chemical resistant clothing (overalls and long-sleeved jacket, coveralls, hooded two-piece chemical splash suit, disposable chemical resistant coveralls
- C-Closed-circuit type filters, supplements, and recirculates exhaled gas.
- C-Compressed Air Breathing Apparatus (CABA) or self-contained breathing apparatus (SCBA) is a Positive pressure device worn by HAZMAT rescue workers, firefighters, and others to provide breathable air in an immediately dangerous to life or health atmosphere. SCUBA (Self-Contained Underwater Breathing Apparatus) has cylinder to go inside deep waters.<sup>15</sup>
- D-Decontamination Showers after handling the suspected victim
- D- Dosimeters should be worn at the neck for easy access by the RSO(Radiation safety Officer)
- E- Eye shield & Ear Plugs in noise reduction in industrial safety
- F-Face Shields for splash/ burst of container
- F-Footwear protection (Disposable)
- G- Goggles (Lightweight, Reusable, Indirect Vented (Splash proof), Clear Vision with a Wide Flange and Latex-free) for examining radioactive substances
- G-Gloves of Yellow Rubber
- G-Gown of plastic covering whole body- like astronaut dress
- H-Helmets to safeguard from Head injury in extrication of victims from collapsed vehicles/buildings

- H-Hood mask with Oxygen cylinder, for going inside closed spaces with toxic fumes
- H-High visibility clothing- fluorescent stripes
- I-Isolation

PPE is divided into four categories based on the degree of protection afforded.

- 1) Level A protection should be worn when the highest level of respiratory, skin, eye and mucous membrane protection is needed.
- 2) Level B protection should be selected when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection is needed.
- 3) Level C protection should be selected when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely.
- 4) Level D protection is primarily a work uniform and is used for nuisance contamination only.<sup>16</sup>

### *Management and Prevention of Industrial Accidents*

The Chain of Survival in Industrial Emergencies and Disasters is similar to the cardiac arrest chain of survival of the American Heart Association (AHA) and the trauma chain of survival. It is a sequence of five inter-linked rings, which when practiced, decreases the mortality and morbidity in the concerned population.

The second ring is Early Recognition. Industrial workers and surrounding communities should be equally trained in hazard and risk analysis along with vulnerability assessment.

The third ring is Access to Care by the Early Response System, involving a universal emergency response number and early intervention by on-site trained medical professionals. This ring emphasizes the importance of a link with the surrounding communities, as they are the first responders and the front-line victims.

The fourth ring is Early Advanced Care by EMS for transportation to hospitals or by Emergency Department personnel in referral hospitals.

The fifth and the last ring is Early Rehabilitation, which includes integrated post emergency care, over all rehabilitation and early return to work.

The METHANE report for reporting disasters

concisely an easy Mnemonic.<sup>17</sup>

- M - Major incident
- E - Exact location
- T - Type of incident
- H - Hazards present and anticipated
- A - Access routes
- N - Number and type of injuries and casualties
- E - Emergency services present and required

The key to successful implementation of Chain of Survival is to have identified components of care, training and quality monitoring. When practiced diligently, this could help prevent industrial disasters, and mitigate their harmful effects on occurrence.<sup>17</sup>

### **Conclusion**

It's popular Myth among professionals that all Industrial accidents are unpredictable, unpreventable and unsalvageable. But the Fact is that some of Industrial accidents are avoidable, and preventable. And we can prepare our Emergency Medical Services for better management by stocking the relevant antidotes, thus preventing mortality & morbidity by public awareness of possible casualties nearby those industries. Laws & legal acts discussed, provide concrete regulations for punishing the accused causing negligent acts, resulting in mass casualties

***Conflict Of Interest: Nil***

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