



Ministry of Health & Family Welfare
Government of India



World Health
Organization
India

Medical Management

of Chemical Emergencies



2025

Medical Management

of Chemical Emergencies



In hospital Medical Management at the Emergency Department.

The “Medical Management of Chemical Emergencies” is a specialized module that focuses on providing medical professionals with the knowledge and skills necessary to manage chemical emergencies. The module is designed to cover a wide range of topics related to the medical management of chemical emergencies, including in hospital patient triage, hospital decontamination, the initial assessment and management and the appropriate use of personal protective equipment. The module is typically offered as part of advanced training programs for medical professionals such as emergency medicine physicians, staff in the emergency medicine department ,hospital administrators and management,related specialist doctors and other hospital staff. The module may also be included as part of broader public health management training programs for first responders, public health professionals ,government officials and other relevant stakeholders.



Initial Treatment being Provided at the Emergency Rooms



ACKNOWLEDGEMENT

India is rapidly emerging as a major global hub for industrial and technological development. As chemicals form an integral part of modern industrial systems, the pace of industrialization has simultaneously heightened the risk of exposure to chemical hazards. Uncontrolled releases of such substances can have serious implications for public health and the environment, potentially resulting in chemical emergencies. These chemical emergencies have a profound impact on human health, often resulting in casualties, long-term consequences, and damage to property and the environment.

These modules have been developed recognizing the importance of addressing public health concerns arising from chemical incidents. India's health sector is expanding its role and aligning with the International Health Regulations (IHR) to strengthen capacities for chemical emergency preparedness and National Centre for Disease Control (NCDC), as the national focal point for IHR implementation, coordinates with relevant sectors to enhance capacities for the management of chemical emergencies and undertakes capacity-building initiatives across all related core areas.

The Public Health Management of Chemical Emergencies modules are the outcome of an extensive process of consultation and collaboration among national and international experts, practitioners, and institutions engaged in health emergency preparedness, disaster risk management, and chemical safety, through a series of technical consultations, systematic peer reviews, and capacity-building workshops convened to ensure the relevance and applicability of the content to India's health and disaster management systems context.

From the Conceptualization, Contribution, Development and further scaleup capacity building efforts for Public Health Preparedness for Chemical Emergencies, the collective insights and experiences of all contributors have shaped this module into a practical tool to strengthen preparedness, response, and resilience against chemical emergencies across all levels of the health system.

We extend our sincere gratitude to the National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF), Ministry of Health and Family Welfare (MoHFW), Ministry of Chemicals and Fertilizers, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, Office of The Principal Scientific Advisor to the Prime Minister, Defense Research and Development Establishment (DRDE), National Authority for Chemical Weapons Convention (NACWC), National Institute of Disaster Management (NIDM), Directorate General of Factory Advice Service and Labour Institutes (DGFASLI), Disaster Management Institute (DMI) Bhopal, Employees' State Insurance (ESI) Hospitals, All India Institute of Medical Sciences (AIIMS), Indian council of medical research (ICMR), State Disaster Management Authorities, Gujarat Institute of Disaster Management (GIDM), State Governments, Local governments, Industry partners, World Health Organization (WHO) India - State and Field offices teams, and other institutions, hospitals and stakeholders who contributed to the development of the Chemical Emergencies Module. Your expertise and collaboration have been instrumental in shaping this module and enhancing preparedness, response and management for chemical emergencies.

ABBREVIATIONS

AAR	After Action Review
ALS	Advanced Life Support
BIS	Bureau of Indian Standards
BLS	Basic Life Support
CA (EPPR) Rules	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
CAS	Crisis Alert System
CCG	Central Crisis Group
CCR	Central Control Room
CFEES	Centre for Fire, Explosive and Environment Safety
CPCB	Central Pollution Control Board
CSR	Chemical Safety Report
CLI	Central Labour Institute
DAE	Department of Atomic Energy
DGFASLI	Directorate General Factory Advice Service and Labour Institutes
DDMA	District Disaster Management Authority
DISH	Directorate of Industrial Safety and Health
DM	Disaster Management
DMP	Disaster Management Plan
DOCP	Department of Chemicals and Petro-chemicals
EMS	Emergency Medical Services
EPA	Environmental Protection Act
ERF	Environment Relief Fund
ES	Exposure Scenario
EOC	Emergency Operations Centre
FE	Functional Exercise
FSE	Full-Scale Exercises
GIS	Geographic Information System
HAZAN	Hazard Analysis
HAZCHEM	Hazardous Chemical
HAZMAT	Hazardous Material
IDSP	Integrated Disease Surveillance Program
IHR	International Health Regulations
ILO	International Labour Organization
MAH	Major Accident Hazard
MoEFCC	Ministry of Environment, Forests and Climate Change
MoHFW	Ministry of Health & Family Welfare
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NIDM	National Institute of Disaster Management
OISD	Oil Industry Safety Directorate
OR	Operational Requirements
PESO	Petroleum & Explosives Safety Organization
PPE	Personal Protective Equipment
PCC	Pollution Control Committees
RLI	Regional Labour Institute
RMM	Risk Management Measures
RRT	Rapid Response Team
SAICM	Strategic Approach to International Chemicals Management
SDMA	State Disaster Management Authority
SPCB	State Pollution Control Boards
WHO	World Health Organization
TTX	Tabletop Exercise

SYMBOLS



INDUSTRIAL ZONE



TOXIC MATERIALS



CORROSION

WARNING OF
SLIPPERY SURFACE

EXPLOSIVE MATERIAL



WEAR RESPIRATOR

WARNING OF
GENERAL HAZARD

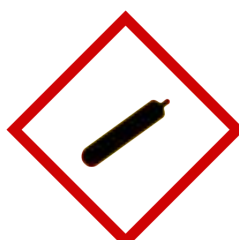
FLAMMABLE MATERIALS



OXIDIZING AGENT

CHEMICAL
STORAGE AREA

WEAR SAFETY GLOVES

WARNING OF
MOVING MACHINERYSTRONG
MAGNETIC FIELDGAS UNDER
PRESSUREELECTRICAL
HAZARDHAZARD TO
ENVIRONMENT

TOXIC MATERIALS

WEAR SAFETY
HELMET

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"Hope for the best, plan for the worst"

INTRODUCTION

By the end of this chapter, you will be able to understand:

1. What are chemical emergencies?
2. What are the causes of chemical emergencies?
3. What is the need for the management of chemical emergencies?

1.1 Hazardous Chemicals

Hazardous chemicals are substances which are capable of causing adverse effects to people and/or the environment under conditions of exposure. Hazardous materials are poisonous by-products produced in manufacturing, farming, construction, automotive, laboratories, and hospitals which may contain chemicals, heavy metals, radiation, dangerous pathogens, or other toxins. Common examples are Hydrogen cyanide, Hydrogen sulfide, Nitrogen dioxide, Ricin, Organophosphate pesticides, Arsenic etc.

Toxic waste has become more abundant since the Industrial Revolution, causing serious global health issues. Disposing of such waste has become even more critical with the addition of numerous technological advances containing toxic chemical components. Even households generate hazardous waste from items such as batteries, used computer equipment, and leftover paints or pesticides. Toxic materials can either be human-made and others are naturally occurring in the environment. Not all hazardous substances are considered toxic.

1.1.1 Routes of Chemical Exposure

1. **Ingestion** - Absorption through the digestive tract. This process can occur through eating with contaminated hands, through contaminated food or in contaminated areas.
2. **Absorption** - Absorption through the skin often causes dermatitis. Some toxins that are absorbed through the skin or eyes can damage the liver, kidney, or other organs and through misuse of sharp materials such as hypodermic needles.
3. **Inhalation** - Absorption through the respiratory tract (lungs) through breathing. This route is the most critical in terms of severity.
4. **Injection** - Percutaneous injection of a toxic substance through the skin. This process can occur in the handling of sharp-edged pieces of broken glass apparatus and through misuse of sharp materials such as hypodermic needles. (Fig 1)

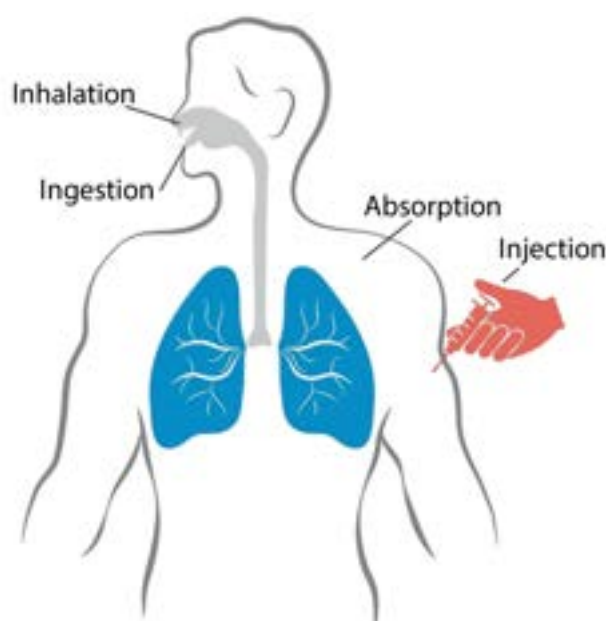


Fig. 1 : Routes of chemicals entering the body

1.2 Chemical Hazards

- Chemical emergencies can occur when hazardous substances are released into the environment, either accidentally or intentionally. These substances can pose a serious threat to human health and the environment, and it is important to respond quickly and effectively to minimize the potential damage.
- Chemical emergencies can range from small spills that can be contained relatively easily, to large-scale disasters that require a coordinated response from multiple agencies and organizations.
- It is essential to have plans and protocols in place to manage chemical emergencies, including strategies for assessing the situation, evacuating affected areas, and providing medical treatment to those who have been exposed to the hazardous substances.
- Proper training, equipment, and communication are also critical components of any effective response to a chemical emergency. The use of chemicals to enhance and improve life is a widespread practice worldwide. While on one side, there are benefits of using these chemicals, on the other side, there is also potential for adverse effects on people and the environment.

Chemical emergencies are sudden in nature, provide less time to think and act and consequences are catastrophic. In case of chemical emergencies, the abnormal situation involving chemicals demands prompt action to mitigate the associated hazards such as fire, explosion, toxic gas release, etc.



Major classes of corrosive substances are:

1. Strong acids (e.g., Sulphuric, Nitric, Hydrochloric & Hydrofluoric acids)
2. Strong bases (e.g., Sodium hydroxide & Potassium hydroxide)
3. Dehydrating agents (Sulphuric acid, Sodium hydroxide, Phosphorus pentoxide, & Calcium oxide)
4. Oxidizing agents (e.g., Hydrogen peroxide, Chlorine, & Bromine)



Important properties of flammable liquids:

- » Flash point is the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with air.
- » Ignition temperature is the minimum temperature required to initiate self-sustained combustion



1. Oxidizers: An oxidizing agent is any material - initiates or promotes combustion in other materials, either by causing fire itself or by releasing oxygen or other combustible gases. Examples of Oxidizers - Aluminum nitrate, Ammonium persulfate, Barium peroxide.
2. Reactives: Reactives include materials that are pyrophoric ("flammable solids"), are water reactive, form explosive peroxides, or may undergo such reactions as violent polymerization.



» Examples – Hydrogen cyanide, Hydrogen peroxide, Hydrogen fluoride etc.

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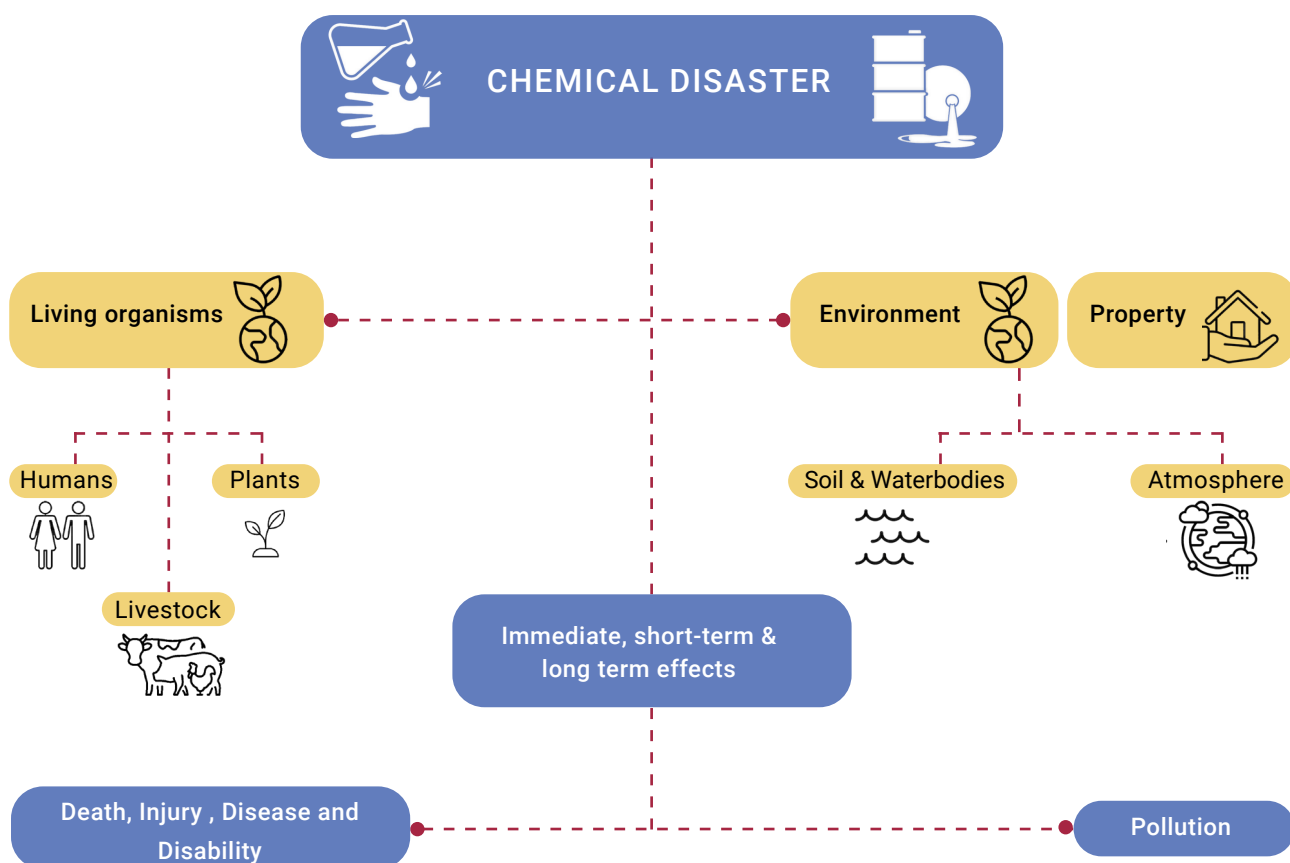


Fig.3 : Effects of Chemical Disaster

The various hazards associated with chemicals may be broadly put into three main categories-

- **Physical Hazards**, such as explosive, inflammable solid/liquid/gas, self-reactive substances; oxidizing liquid/solid; pyro-phoric liquids/solids etc.
- **Health Hazards**, such as acute toxicity-oral or dermal; skin corrosion/irritation; serious eye damage/eye irritation; respiratory/skin sensitization; specific target organ toxicity; germ cell mutagenicity; carcinogenicity, reproductive toxicity, aspiration hazard, secondary infections, radiotoxicity etc.
- **Environmental Hazards**, such as very toxic/toxic/harmful to aquatic life; adverse impact on ozone layer, etc.



1.4 Causes of Chemical Emergencies

Chemical emergencies can occur due to different types of hazardous substances, including toxic chemicals, gases, and radioactive materials. They can be released into the environment due to various reasons, such as:

1. Natural disasters leading to chemical emergencies -

Natural disasters such as floods, earthquakes, and cyclone can damage industrial facilities and release hazardous substances into the environment. for Eg Sandhurst Chemical blast, Gloucestershire, UK in 2000 following floods, AKSA Acrylic Fibre Plant disaster following Earthquakes in Turkey in 1999.

2. Manmade disasters -

These include accidents at industrial facilities, during transport, storage and use of Hazardous Chemicals. These accidents can lead to the release of toxic chemicals, explosions, and fires for eg: Tulgalkabad Gas Leak, Delhi 2017, Fire at Indian Oil Corporation, Jaipur, 2009.

3. Deliberate acts of terrorism -

Chemical emergencies can also be caused by deliberate acts of terrorism for E.g. Sarin gas attack at Tokyo subway, Japan 1995.



a) AKSA acrylic fiber plant disaster post Earthquake, Turkey, 1999



b) Indian Oil Corporation, Jaipur fire, 2009



c) LPG tank farm at the Chiba refinery Japan after the earthquake,



d) Release of nerve gas in the Tokyo subway in 1995

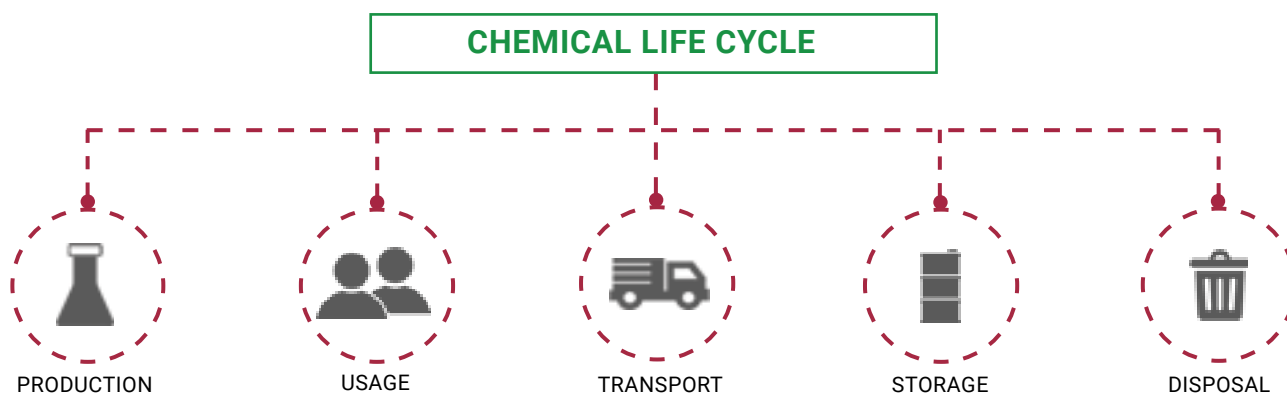


Figure 4 - Components in Chemical Disaster Management



1. Chemical Emergency during Production - Bhopal Gas Tragedy, 1984, Madhya Pradesh



2. Chemical Emergency during Usage - Hapur Factory boiler explosion, Lucknow, 2022, Uttar Pradesh



3. Chemical Emergency during Transportation - Kanpur LPG Truck explosion, 2001, Uttar Pradesh



4. Chemical Emergency during Storage - Gas leakage in LG Polymers Visakhapatnam, 2020, Andhra Pradesh



5. Chemical Emergency during Disposal - Mumbai port trust - Sewri chlorine leak, 2010, Maharashtra



1.5 Need for management

The management of chemical emergencies is essential to protect human health, wildlife, and the environment from the harmful effects of hazardous substances. Chemical emergencies can occur due to various reasons, including accidents at industrial facilities, transportation mishaps, natural disasters, and deliberate acts of terrorism. These emergencies can have immediate and long-term impacts on the health and safety of individuals, wildlife, and ecosystems.

Effective management of chemical emergencies can help to minimize the potential damage caused by such events. Emergency planning and preparation can help to identify potential hazards and develop procedures for responding to emergencies, including notification, evacuation, and communication protocols.

The components in chemical disaster management are mentioned in figure 5.



Figure 5 - Components in Chemical Disaster Management



Bhopal Gas Disaster - Plant structure UCIL Factory, 1984



Bhopal Gas Disaster, 1984



“Failing to prepare is preparing to fail”

EXISTING REGULATORY & INSTITUTIONAL FRAMEWORKS

By the end of this chapter, you will be able to understand:

1. What are the list of laws and acts pertaining to the Management of Chemical Events
2. What are MAH Units?

2.1 List of Laws and Acts related to the Management of Chemical Emergencies in India

NAME OF THE ACT/LAW/RULES	PROVISIONS
 The Water (Prevention and Control of Pollution) Act, 1974	Provides for the prevention and control of water pollution and the establishment of boards for the prevention and control of water pollution.
 The Environment (Protection) Act, 1986	Provides for the protection and improvement of the environment and the prevention of hazards to human beings, other living creatures, plants, and property.
 The Manufacture, Storage, and Import of Hazardous Chemicals Rules, 1989	Provides for the regulation of the manufacture, storage, and import of hazardous chemicals.
 The Public Liability Insurance Act, 1991	Provides for mandatory insurance coverage for industrial units handling hazardous substances to compensate for the damages caused to third parties in case of an accident.
 The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996	Provides guidelines for emergency planning, preparedness, and response in case of a chemical accident.
 The Disaster Management Act, 2005	Provides for the management of disasters, including chemical disasters, and the establishment of institutions for disaster management.
 The Petroleum and Natural Gas Regulatory Board (Emergency Management Plan) Regulations, 2010	Provide for the establishment of emergency management plans for petroleum and natural gas installations.
 The Hazardous Waste (Management, Handling, and Transboundary Movement) Rules, 2016	Provides for the management, handling, and transboundary movement of hazardous waste in a safe and environmentally sound manner.

These laws and acts aim to ensure the safe handling, storage, transportation, and disposal of hazardous chemicals, and to prepare and respond to chemical emergencies effectively.



Amendments to Pre-Bhopal legislations including Factory Safety Act and Motor Vehicles Act.

- o The Insecticides Act, 1968 (amended 2000) and The Insecticide Rules, 1971 (amended 1999).
- o The Motor Vehicles Act, 1988 (amended 2001).
- o The Central Motor Vehicles Rules, 1989 (amended 2005).
- o The Explosives Act, 1884 (amended till 1983).
- o The Gas Cylinder Rules, 2004.
- o The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002).
- o The Explosives Rules, 1983 (amended 2002).

Apart from the above, legal instruments for the management of hazardous wastes include the Biomedical Wastes (Management & Handling) Rules, 1998 and the Batteries (Management & Handling) Rules, 2001(amended 2010) ,Battery Waste Management Rules 2022, Hazardous Microorganism Rules, 1989. Major responsibility for implementing these Rules is with the Central Pollution Control Board and State Pollution Control Boards (SPCBs) / Pollution Control Committees (PCCs) and also with the State Departments of Environment.

These laws and acts aim to ensure the safe handling, storage, transportation, and disposal of hazardous chemicals, and to prepare and respond to chemical emergencies effectively.

2.2 Environmental Regulations: Liability and Litigations

- o Development of legislation in area of chemical disaster management owes to environmental jurisprudence and also to the lawsuits in form of public interest litigations.
- o Under the Public Liability Insurance Act, 1991 as amended in 1992, all the MAH units handling chemicals in excess of the threshold quantities referred to in the Schedule, are mandated to take an insurance policy before starting their activity, on behalf of the off-site population, and deposit an equal amount in the Environment Relief Fund (ERF) to ensure immediate payment to the chemical accident victims.
- o This relief shall be paid on "Principle of no fault" that is the claimant shall not be required to plead or establish that the death, injury or damage was due to any wrongful act neglect or default.
- o The National Environment Tribunal Act, 1995 is enacted to setup legal institutions across the country to provide for strict liability for damages arising out of accidents occurring during the handling of hazardous substances and for establishment of National Environment Tribunal for effective and expunction disposal of cases arising from such accidents, with a view to giving relief and compensation for damages to person, property and the environment.
- o Several verdicts of the Hon'ble Supreme Court of India under the Article 21, Right to Life also provided standards for the environmental jurisprudence in the country.
- o A number of chemical specific codes of practices published by the Bureau of Indian Standards (BIS), the Oil Industry Safety Directorate (OISD) and guidelines brought out for chemical accident management by the Ministry of Environment, Forest and Climate Change (MoEFCC).



2.3 International Health Regulations (IHR) and Chemical Events

The chemical industry is one of the largest economic sectors worldwide. Despite the omnipresence of chemicals worldwide and their predicted increase in production and use, many countries lack adequate capacities to deal with the health aspects of chemical events and emergencies. In 2005 the WHO Member states adopted the revised IHR (2005) which included Chemical events.

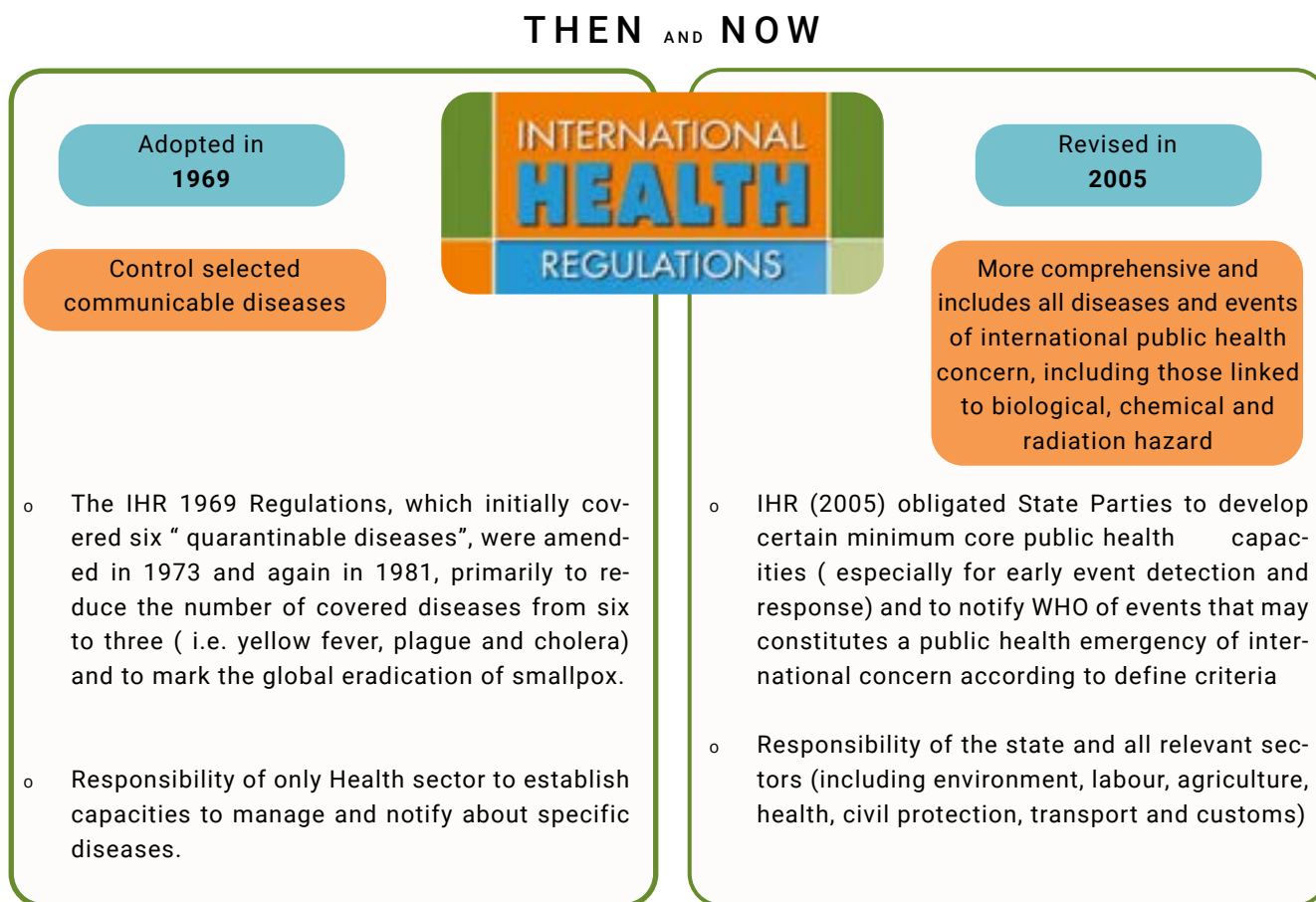


Fig.6 : IHR in 1969 vs IHR 2005

- A new fund for pandemic prevention, preparedness and response the revision of the International Health Regulations (IHR) were ongoing initiatives aimed at enhancing global health security and improving the international response to public health emergencies
- Pandemic Accord-Member States of the World Health Organization have agreed to a global process to draft and negotiate a convention, agreement or other international instrument under the Constitution of the World Health Organization to strengthen pandemic prevention, preparedness and response.
- Pandemic Accord, International Health Regulations Amendments and Health Emergency Preparedness and Response (HEPR) are thus the upcoming instruments that focus on concept of building and strengthening capacities and fostering coordination. The worldwide production, trade and use of chemicals are predicted to increase further, particularly in developing countries like India thus the importance of these treaties and regulations

01

POLICY PLANNING AND COORDINATION

- Capacity building of designated focal points for the IHR in all authorities i.e., health sector, labour, environment, agriculture, transport, security etc., that have important role in the management of chemical events
- Others - operators, emergency services, workers, customs, food authorities, consumer protection organizations, academia and public

02

PREPAREDNESS AND CAPACITY BUILDING

- Multi-disciplinary response requiring a range of skills and expertise.
- Training for individuals and organizations with specific responsibilities.
- Poisons Centres as key sources of expertise.

03

EVENT DETECTION, VERIFICATION AND RISK ASSESSMENT

- Multi-hazard surveillance strategy
- An integrated surveillance system should link these important sources of information about chemical events together and be supported by a surveillance plan. Multiple sources of notification and alert:
 1. Within health sector - Poison Centres, hospital emergency departments, primary health-care facilities and toxicology laboratories
 2. Outside health sector - agency for consumer protection and food safety, plant operators, environmental agencies (surface water, air and soil), first responders, public/community (overt release, such as an explosion, a chemical plume, contaminated drinking water, dirty surface water or dead wildlife)

04

EMERGENCY RESPONSE

- Authorities respond by evaluating risks and implementing actions based on guidelines.
- National chemical event emergency response plan is crucial.
- Consideration of existing legal and technical instruments or plans.

05

CHEMICAL EVENT SCENARIO ANALYSIS

- Technique to explore how chemical events occur and their consequences which guides the building of surveillance and response plans and related capacities.
- Monitoring national and international chemical events to identify major impacts, and risks
- Risk mapping - inventories of major hazard sites

06

INTERNATIONAL CHEMICAL SAFETY AGREEMENTS

- Responsibility usually with ministries of environment or industry.
- Recognition of the need for a multisectoral approach.
- Sectors should be aware of and collaborate with each other.



2.4 Major Accident Hazard (MAH) units

In India, Major Accident Hazard (MAH) installations are regulated under the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989, which were amended in 2000 and 2009. MAH installations are those that handle hazardous substances in large quantities and have the potential to cause major accidents that can result in loss of life, property, and environmental damage.

TYPES OF MAH INSTALLATIONS

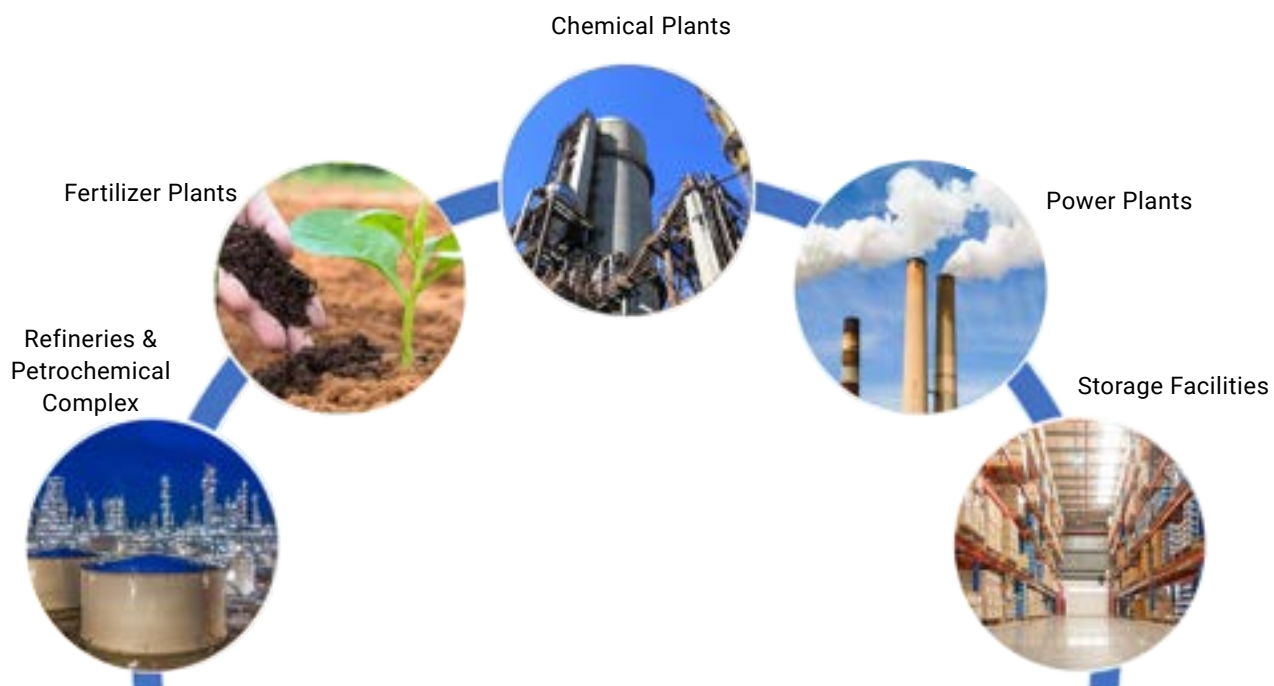


Fig.7 : Types of MAH units

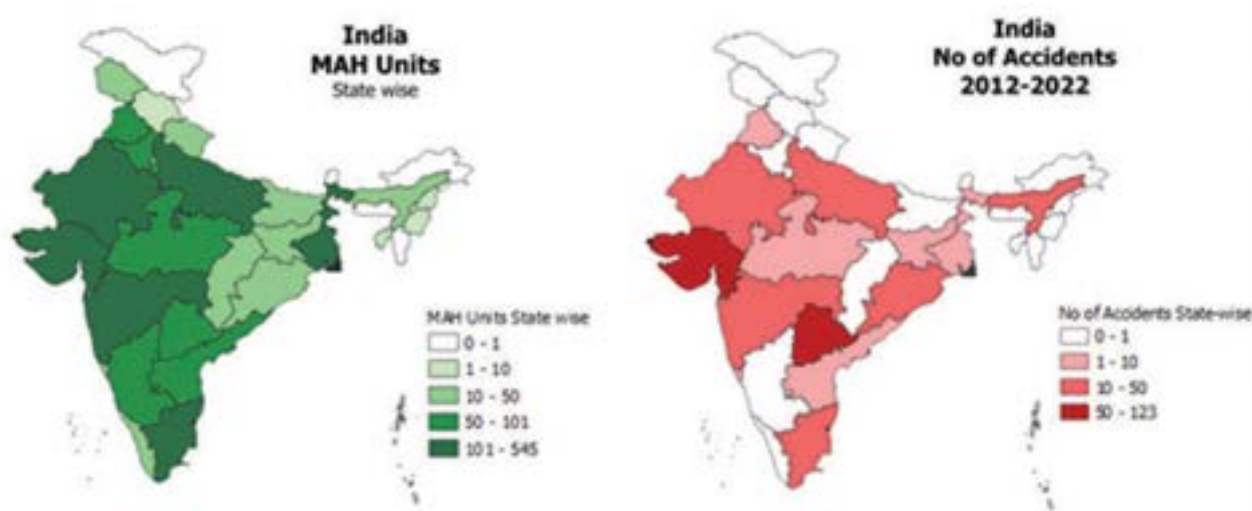


Fig. 8 : No of MAH Units state-wise. Ref: Data from MoEFCC & No of Accidents state wise in last 10 years (2012-2022)



Indian Oil depot fire, Jaipur, Rajasthan, 2009







"In times of disaster, we all play a role"

INSTITUTIONAL MECHANISMS

By the end of this chapter, you will be able to understand:

1. List of stakeholders with their roles and responsibilities in the management of chemical emergencies
2. What are Crisis Group and Directorate of Industrial Safety and Health (DISH) Centres
3. What is the role of RRT Team and Surveillance officers during chemical emergencies

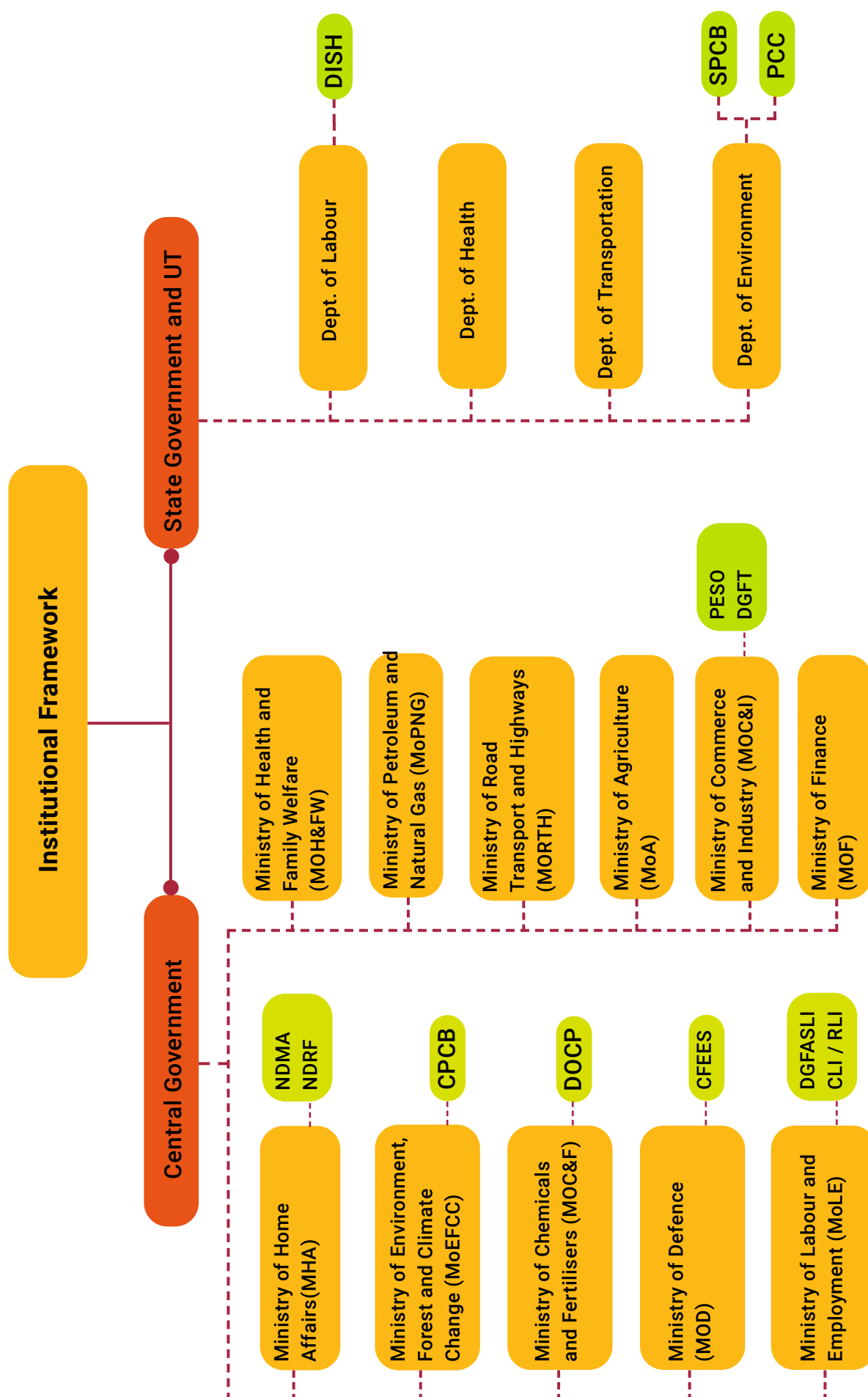


Fig. 9 : Institutional Framework for chemical emergencies

* Adapted from NDMA guidelines on chemical disasters



3.1 List of stakeholders and their roles and responsibilities in the management of chemical emergency

There has been a paradigm shift from relief centric approach to pre-disaster preparedness and mitigation since the 1999 super cyclone in Odisha for disaster management in India. The Disaster Management Act (DM Act, 2005) provides for the establishment of National Disaster Management Authority, State Disaster Management Authority, District Disaster Management Authority and Local Disaster Management Authority. The legal and institutional mechanism set up by the Environmental Protection Act (EPA), 1986 has been dovetailed with the DM Act, 2005. Convergence of institutional mechanisms for chemical disasters with the holistic disaster management framework is essential for achieving this goal.

In India, at the national level following ministries are involved in chemical disaster management:

- o Ministry of Environment, Forests and Climate Change (Nodal Ministry)
- o Ministry of Home Affairs
- o Ministry of Health and Family Welfare
- o Ministry of Chemicals and Fertilizers
- o Ministry of Defence
- o Ministry of Labour & Employment
- o Ministry of Petroleum and Natural Gas
- o Ministry of Commerce and Industry
- o Ministry of Road Transport and Highways of India
- o Ministry of Agriculture
- o Ministry of Finance

Various departments related with Central level ministries include :

- o **CPCB** - Central Pollution Control Board
- o **NDMA** - National Disaster Management Authority
- o **NDRF** - National Disaster Response Force
- o **DGFASLI** - Directorate General Factory Advice and Labour Institutes
- o **CLI** - Central Labour Institute, Mumbai,
- o **DAE** - Department of Atomic Energy
- o **RLI** - Regional Labour Institutes
- o **CFEES** - Centre for Fire, Explosive and Environment Safety
- o **DOCP** - Department of Chemicals and Petrochemicals
- o **PESO** - Petroleum and Explosives Safety Organization

The other associated research institutes and organizations working in the field of chemical emergencies include - Defence R&D Establishment (DRDE) which is the nodal laboratories of Defence Research & Development Organization (DRDO) for providing technological solutions for chemical and biological defence, and National Institute of disaster management (NIDM), Indian Institute of Chemical Technology (IICT), Hyderabad; Indian Institute of Toxicology and Research (IITR), Lucknow, National Environmental Engineering Research Institute (NEERI), Nagpur; National Chemical Laboratory (NCL), Pune and National Institute of Occupational Health (NIOH), Ahmedabad, which work in the field of occupational hazard and safety. Limited facilities for the collection of environmental toxicants, released during a chemical disaster also exist in the Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR).

Following departments are responsible for Chemical disaster management at the state Level,

- o Department of Labour - DISH
- o Department of Health
- o Department of Environment - State Pollution Control Board (SPCB) and Pollution Control Committees (PCC).
- o Department of Revenue and Disaster Management



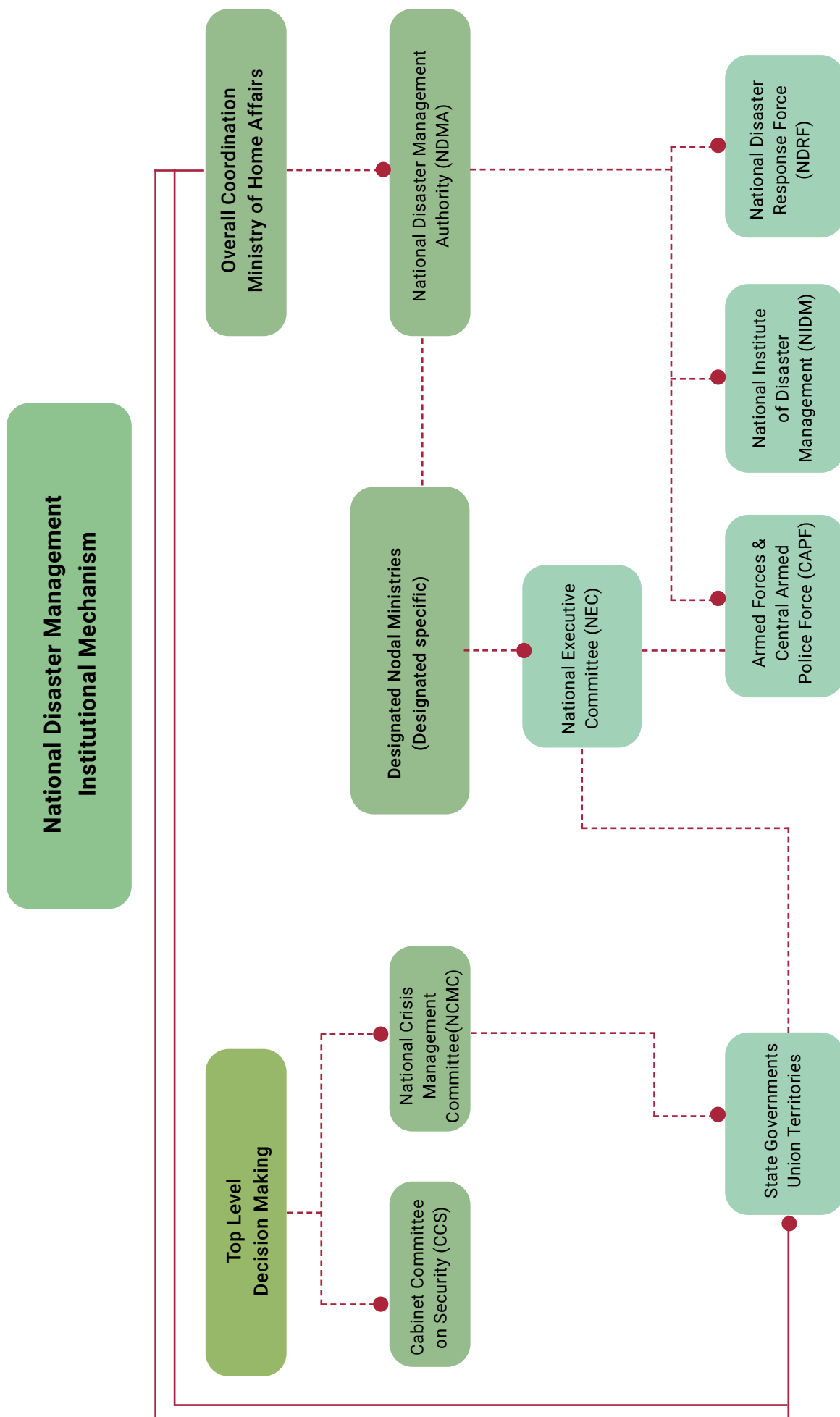


Fig.10 : Components in Chemical Disaster Management

* Adapted from NDMA guidelines on chemical disasters



3.1.1 National Disaster Management Institutional Mechanism

- o Ministry of Home Affairs is the responsible Ministry for overall coordination of disaster management in the country. There are nodal ministry identified for various disasters, for example, Ministry of Environment & Forests for Chemical Disasters, Ministry of Health and Family Welfare for Biological disasters, Ministry of Atomic Energy for Nuclear Disasters, Ministry of Railways for Rail accidents, etc. Ministry of Agriculture now looks after Drought.
- o For chemical disaster management in our country, many ministries are involved – Ministry of Environment and Forests, Ministry of Labour & Employment, Ministry of Agriculture, Ministry of Petroleum and Natural Gas, Ministry of Commerce and Industry, Economic Affairs & Finance, Ministry of Road Transport & Highways takes care of the aspects related to accidents during road transport of chemicals.
- o There is a National Crisis Management Committee that meets at the time of a calamity but not in the pre-disaster stage. At the time of a calamity of national scale, crisis management committee under the chairmanship of the Cabinet Secretary gives policy directions and guidelines for the crisis management group where the national and international efforts are required.
- o Crisis management Group at the Ministry of Home Affairs reviews the situation in Inter-ministerial meeting to coordinate various emergency support functions to the affected areas. Union Cabinet can set up the task force or committee for effective coordinate of the relief measures.
- o The National Disaster Management Authority has been constituted under the Chairmanship of the Prime Minister of India. There are nine members in the authority. NDMA's role is to lay down the guidelines and plans for disaster management, development of guidelines of minimum standards of relief, providing guidelines to the state governments and relevant central ministries.
- o Training and education are given significant focus and a number of workshops, training and awareness initiatives have been undertaken by NDMA and NIDM.
- o It is important to note that the roles and responsibilities of these stakeholders may vary depending on the specific circumstances of the emergency and the laws and regulations in place in the affected area.

3.1.2 State Level Disaster Management Coordination Mechanism

- o Similarly there is a mechanism at the state level where the crisis management committee under the Chief Secretary, responsible for the emergency management at state level. This committee comprises of the state departments officers with representative of central government organizations.
- o State Department of Relief has now been changed to Department of Disaster Management , will be the nodal department in coordinating the relief operations and disaster preparedness at the state level. It is also proposed to rename Relief Commissioners as Disaster Management Commissioners.
- o State Disaster Management Authority (SDMA) has the functions at states similar to NDMA has at national level and is chaired by Chief Minister. It provides guidelines to the state departments and the Districts.
- o District Disaster Management Authority is chaired by the District Collector or the District Magistrate. DDMA is responsible for formulation of District Disaster Management Plan. In some states like Gujarat and Odisha the Disaster Management Authority was formed prior to the National Disaster Management Authority. So, in those states now also the chairperson is not the Chief Minister but the Relief Commissioner. This is because these authorities were formed before the enactment of the Disaster Management Act.
- o Odisha Disaster Management Authority (OSDMA) was formed in 2000 and Gujarat Disaster Management Authority (GSDMA) was formed in 2001. Disaster Management Act provides the constitution of a Disaster Response Fund and now a Disaster Mitigation Fund.



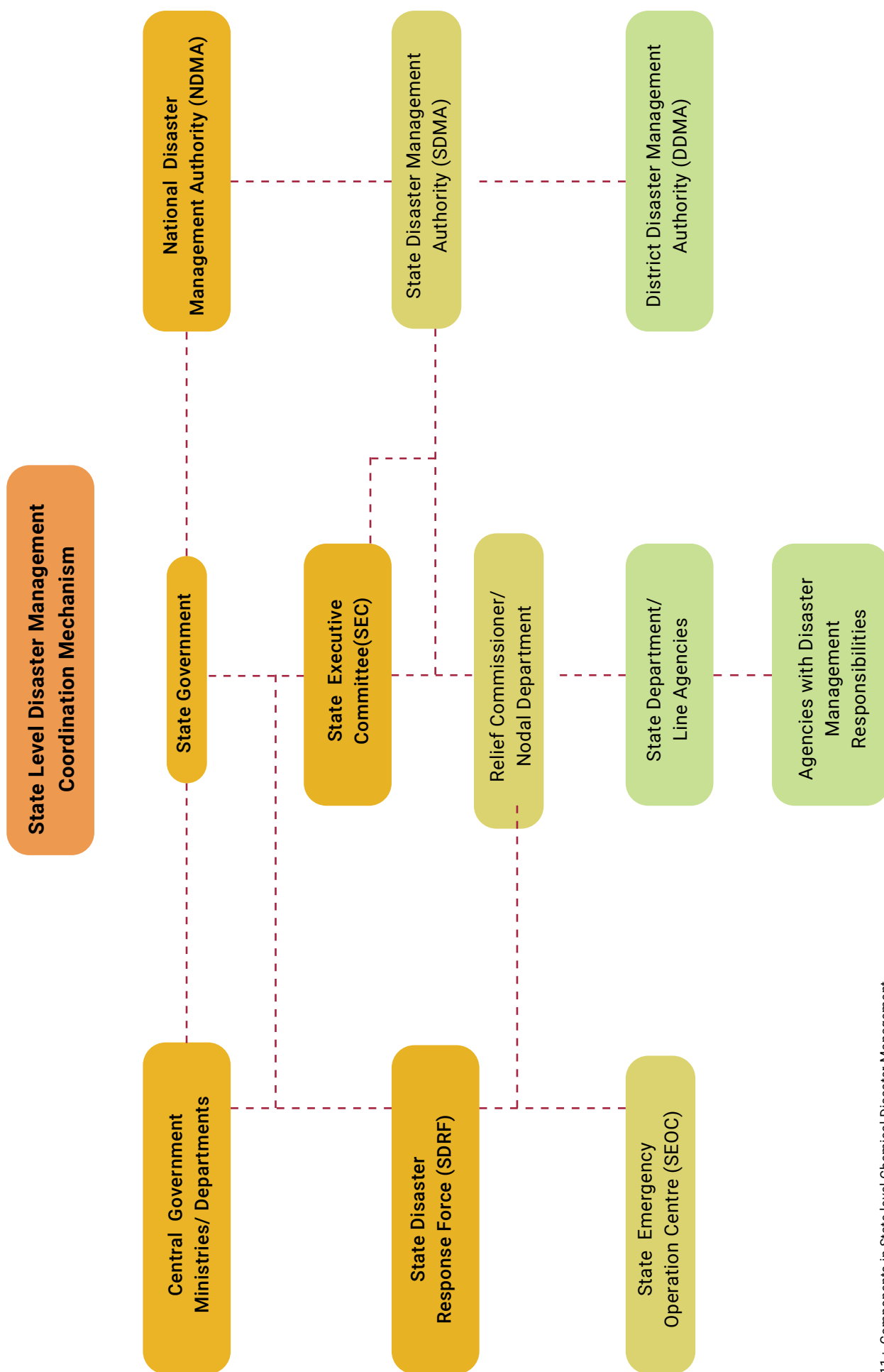


Fig.11 : Components in State level Chemical Disaster Management

* Adapted from NDMA guidelines on chemical disasters



3.2 Crisis Groups

Crisis groups are constituted at the Central, State, District and local (industrial areas) levels. They act as bodies at their respective levels, to deal with chemical accidents and provide expert guidance for handling major chemical accidents.

The Central Crisis Group shall be the apex body at Central level and its functions include

- Continuously monitor the post-accident situation arising out of a major chemical accident and suggest measures for prevention and to check recurrence of such accidents
- Conduct post-accident analysis of such major chemical accidents and evaluate responses
- Review district off-site emergency plans with a view to examine its adequacy in accordance with the Manufacture, Storage and Import of Hazardous Chemicals Rules, and suggest measures to reduce risks in the Industrial pockets
- Review the progress reports submitted by the State Crisis Groups
- Respond to queries addressed to it by the State Crisis Groups and the District Crisis Groups
- Publish a State-wise list of experts and officials who are concerned with the handling of chemical accidents
- Render, in the event of a chemical accident in a State, all financial and infrastructural help as may be necessary.

3.3 Directorate of Industrial Safety and Health (DISH) Centres

- The (DISH) in India is pivotal in safeguarding the health, safety, leave with wages, work-environment, and working hours and welfare of workers across various sectors. It undertakes the enforcement of labour laws within industrial settings and construction sites, ensuring adherence to the Factories Act, the Building and other Construction Workers Act, and related labor legislations. DISH's primary focus is to foster safe working environments through regular inspections and by classifying factories into high, medium, or low risk categories, based on criteria such as the manufacturing process and workforce size. etc.
- DISH from all the states are the members of Technical Committee on Explosives.
- Factories are assigned a risk category by DISH: high-risk for those with significant accident hazards or dangerous operations usually involving over 100 workers; medium-risk for those with hazardous operations or processes with up to 100 workers, and non-hazardous factories employing over 250 workers; and low-risk for non-hazardous factories not engaged in dangerous operations and having fewer than 250 workers.
- Additionally, DISH plays a role in labor welfare through initiatives like the Labour Welfare Fund, which supports activities for employee welfare including social education, vocational training, and recreational programs.
- Overall, DISH is essential in upholding a safe and healthy work environment in India's industrial and construction sectors by enforcing legal standards, conducting inspections, and promoting worker welfare.



3.4 Agencies in the Preparedness, Surveillance & Response to chemical emergencies

3.4.1. National Disaster Management Authority(NDMA)

NDMA has the responsibility for laying down the policies, plans and guidelines for disaster management including chemical disasters for ensuring timely and effective response in the country. NDMA provides directions to ministries, departments and state authorities for the preparation of their detailed disaster management plans and calls for a proactive, participatory, multi-disciplinary and multi-sectoral approach at various levels for chemical disaster preparedness and response.

3.4.2. National Disaster Response Force(NDRF)

It is a specialized force trained to handle various types of disasters, including chemical emergencies, and they are equipped with the necessary expertise, equipment, and resources to effectively respond to such situations.

- **Emergency Response:** They assess the situation, implement safety measures, and initiate rescue operations to protect affected individuals and mitigate the impact of the chemical incident.
- **Containment and Mitigation:** They have specialized knowledge in handling hazardous substances, implementing control measures, and mitigating the risks associated with chemical emergencies.
- **Evacuation and Rescue:** They conduct rescue operations, provide medical assistance to those injured or exposed to hazardous chemicals, and ensure their well-being during the evacuation process.
- **Decontamination:** They establish decontamination zones and follow protocols to ensure the safe removal of hazardous substances from affected individuals, equipment, and the environment.
- **Coordination and Support:** They provide support, technical expertise, and guidance to local agencies involved in the management of such incidents.

3.4.3. National Centre for Disease Control(NCDC)

NCDC is the premier organisation involved Public health activities in the country .NCDC is the International Health regulations (IHR)secretariat in the country and chemical emergencies including transboundary movement of chemicals are major risk to public health. NCDC has been assigned the job of carrying out trainings in chemical hazards prevention and it cooperates with pertinent central and state agencies in the creation of standards, guidelines, and standard operating procedures (SOPs) for chemical disaster management

3.4.4. Other agencies involved in the chemical emergencies management

- **Medical Health and safety agencies:** They are responsible for providing medical treatment to those affected by the emergency, like civil hospital, nearest health facility, specialty hospitals/designated hospitals. They are responsible for ensuring the safety and health of workers during the emergency response.
- **Public health agencies:** Agencies such as the National Centre for Disease Control (NCDC) and local health departments shall monitor and conduct investigations into the health effects of the emergency.
- **Chemical Industries:** Chemical Industries are responsible for cooperating with emergency response teams and providing information about the chemicals involved in the emergency, as well as for taking steps to prevent similar emergencies in the future. (both Big and Small)
- **Media:** The media is responsible for reporting on the emergency, providing accurate information to the public, and serving as a source of information for the public during the emergency.
- **Storage and Transportation Companies:** crucial role in ensuring the safe handling and transport of hazardous materials. They should follow best practices and comply with regulations and contribute to protecting public safety, minimizing environmental impacts, and supporting effective emergency response

3.5 Role of RRT and Surveillance Officers

The role of Rapid Response Teams (RRTs) and Surveillance Officers is critical in the effective management of chemical emergencies.

Rapid Response Teams (RRTs) are specialized teams that are trained to respond quickly and effectively to chemical emergencies. Their main role is to provide immediate assistance to affected people, contain the spread of the hazardous substance, and prevent further damage to the environment. RRTs typically consist of emergency responders, medical professionals, and hazardous materials specialists, who work together to provide a coordinated response to chemical emergencies. Some of their specific tasks include: Assessing the situation: RRTs are responsible for assessing the situation and determining the level of risk to human health and the environment.

- Containing the hazardous substance: RRTs work to contain the hazardous substance and prevent it from spreading to other areas.
- Evacuating affected people: RRTs are responsible for evacuating people who have been exposed to the hazardous substance and transporting them to medical facilities for treatment.
- Providing medical assistance: RRTs work to provide medical assistance to affected people, including administering first aid, providing oxygen, and treating injuries.
- Decontaminating affected areas: RRTs are responsible for decontaminating affected areas and ensuring that the hazardous substance is properly disposed of.

Surveillance Officers are also critical in the management of chemical emergencies. They play a key role in monitoring and identifying any potential health effects associated with exposure to hazardous substances. Some of their specific tasks include:

- **Monitoring affected areas:** Surveillance Officers monitor affected areas for any potential health effects associated with exposure to hazardous substances.
- **Conducting epidemiological investigations:** Surveillance Officers conduct epidemiological investigations to identify the source of exposure and determine the extent of the outbreak.
- **Collecting and analyzing data:** Surveillance Officers collect and analyze data on the number of cases and the severity of symptoms associated with exposure to hazardous substances.
- **Providing recommendations:** Surveillance Officers provide recommendations to emergency response teams



Fig. 12: Massive Fire Breaks Out at Govt Hospital in Amritsar, 2022







"Preparation today ensures a secure tomorrow.."

OVERVIEW OF PREPAREDNESS, SURVEILLANCE & RESPONSE FOR PUBLIC HEALTH MANAGE- MENT OF CHEMICAL EMERGENCIES MODULE

By the end of this chapter, you will be able to understand:

1. Overview of preparedness, surveillance & response for public health management of chemical emergencies

Preparedness, Surveillance & Response for Chemical Emergencies provides guidance on how to prepare for such events, how to detect and monitor chemical releases, and how to respond effectively to minimize the damage caused by such incidents.

It is important for a coordinated and collaborative approach to management of chemical emergencies and highlighting the need for effective communication and information-sharing among all parties involved.

It is an essential resource for anyone involved in the management of chemical emergencies. It provides a comprehensive overview of the key issues and challenges involved in dealing with such incidents and provides practical guidance on how to prepare, detect, and respond to chemical emergencies effectively.

EVENT NOTIFICATION -

Surveillance and Monitoring - surveillance and monitoring systems are critical for effective management of chemical emergencies. They provide important information for decision-making, response planning, and evaluation of the impact of the emergency. By detecting chemical emergencies early and evaluating their risks and impact, surveillance and monitoring systems can help protect public health and minimize the environmental impact of these incidents.

Risk assessment of the event - risk assessment can help to minimize the potential harm and damage caused by a chemical event and ensure that appropriate measures are taken to protect people, the environment, and infrastructure.

Assessment of preparedness measures:

- o Facility readiness, local and national chemical incident response plans (with health involvement).
- o Databases on chemicals, sites, transport routes and expertise.
- o Mechanism for interagency communication and public communication.
- o Emergency response guidelines, including environmental protection guidelines.
- o Capacity building plans- undertaking incident exercises, training, and audits.
- o Capacity for chemical incident surveillance.
- o Health system capacities in health facilities to decontaminate and treat casualties

CAPACITY BUILDING PROGRAMS

Capacity building is an ongoing process that equips officials, stakeholders and the community to perform their functions in a better manner during a crisis/disaster. In the process of capacity building, we must include elements of human resource development, i.e., individual training, organizational development such as improving the functioning of groups and organizations and institutional development.

ADVOCACY AND SENSITIZATION OF STAKEHOLDERS

Organizations can create a network of informed and prepared individuals who can work together to respond to chemical emergencies and protect public health and the environment. It is important to tailor sensitization efforts to the needs and priorities of each stakeholder group and to continuously evaluate and improve the effectiveness of these efforts.

CASE STUDY 1 :

OIL SPILL FOLLOWING TYPHOON HAIYAN, ESTANCIA, PHILIPPINES, 2013

On 8 November 2013 Typhoon Haiyan hit the Philippines. National authorities reported 14.1 million affected people and about 6150 deaths. About 1.1 million homes were damaged and half of them completely destroyed. About thirty kilometres south of Estancia saw the leak of more than 800 000 litres of heavy bunker C fuel. Numerous households were evacuated from this area due to health and safety concerns mainly with respect to unintentional fires and accidents, together with the possibility of toxic gases evaporating from the oil. Main routes were extensively destroyed by the typhoon, and distant locations were inaccessible for logistical support. Both the oil and the debris contaminated by it were physically cleaned up by people. People who lacked proper protective gear were exposed to oil on their skin. The site's inaccessibility caused a delay in the arrival of the mechanical clean-up equipment. Furthermore, severely damaged homes and schools remained inaccessible until the end of December. Oil spills contaminated kilometers of coastline, harming both vegetation and fauna. Debris tainted with oil was still present along the shore, and the sand was contaminated to a depth of 10–20 cm. The oily debris had to be transported to another island due to the lack of an industrial waste treatment plant in the area that could manage it, which resulted in extra expenses and the requirement for control measures.

Lessons Learned

- Proper hazard mapping should be undertaken before construction of critical and dangerous infrastructures.
- Timely evacuation and resettlement of the affected population should be undertaken to prevent the long term side effects in them.
- The decontamination and cleaning process in chemical and oil spills should be undertaken only by specialized teams.







"Risk assessment is not about predicting the future, it's about reducing uncertainty"

OVERVIEW OF PRE-HOSPITAL MANAGEMENT OF CHEMICAL EMERGENCY MODULE

By the end of this chapter, you will be able to understand:

1. Overview of pre-hospital management of chemical emergencies

The pre-hospital management of chemical emergencies is critical in preventing further harm to the affected individuals and mitigating the overall impact of the incident. Pre-hospital management during chemical emergencies involves a coordinated effort between emergency medical services (EMS), hazardous materials (hazmat) teams, and other response agencies. The goal of pre-hospital management is to identify and assess the extent of the incident, provide medical treatment to those affected, and ensure the safety of first responders and the general public.

The initial response to a chemical emergency involves the activation of the emergency response system, which includes calling the appropriate local emergency number. The dispatcher will then initiate a response from the appropriate agencies, including EMS and hazmat teams. Upon arrival at the scene, the first responders will assess the situation and determine the appropriate course of action. This may include the establishment of a perimeter or evacuation of the affected area. The hazmat team will then identify the hazardous substance and determine the appropriate method for containment and cleanup.

The medical response to a chemical emergency involves the identification and treatment of those affected by the hazardous substance. The first priority is to ensure the safety of the responders and the general public. This may involve the use of personal protective equipment (PPE) and decontamination procedures to prevent the spread of the hazardous substance. The medical treatment of those affected will depend on the type and severity of the exposure.

In the first minutes of the incident

The first few minutes of a chemical incident are critical. The decisions made and actions taken during this period will often determine the success of the response – and whether lives are saved or lost.

Assess whether Chemicals were involved-

- Is there anything unusual in what we see?
- Are there obvious signs of chemical release - dirty water , airborne contaminant plume, droplets, mist, smoke

Chemical Alert Activation

- The chemical alert is to be activated if there is substantial evidence of chemical release
- Notification of a chemical release is provided by the site/industry responsible for the release
- Notification regarding visible evidence of a release from the public
- The surveillance systems show warning signals such as the occurrence of a chemical event or a sudden increase in levels of a contaminant in the environment
- Trained public health officials , medical professionals reports an event

The evaluation process involves

- Ensuring the safety of the scene
- Analyzing the cause of injury or disease
- Implementing safety measures
- Estimating the number of patients involved
- Assessing the necessity for extra resources
- Secondary evaluations for chemical conditions, and consistent reevaluations

Things to remember in the initial minutes

- Notify local, state, and nodal authorities.
- Notify nearby hospitals and specialized medical centres
- Notify Specialized response forces
- Wear appropriate protective gear for suspected or confirmed nerve-agent poisoning.
- Direct the people to move away from the site of a chemical disaster in a direction opposite to the direction of the prevailing wind
- Initiate decontamination as soon as possible
- The developmental and technical agencies working in the field

The first step is to provide basic life support, including airway management, breathing support, and circulation support, as needed. This may involve the use of oxygen, intravenous fluids, and medications, as appropriate. For those with significant exposures, advanced life support may be necessary. This may involve the use of antidotes or specific treatments for the specific chemical exposure. In some cases, patients may require hospitalization for further observation and treatment. Pre-hospital management during chemical emergencies also includes the management of psychological stressors. The traumatic nature of chemical emergencies can cause significant psychological distress for those involved. Responders and survivors may require counselling and other support services to help them cope with the emotional impact of the incident

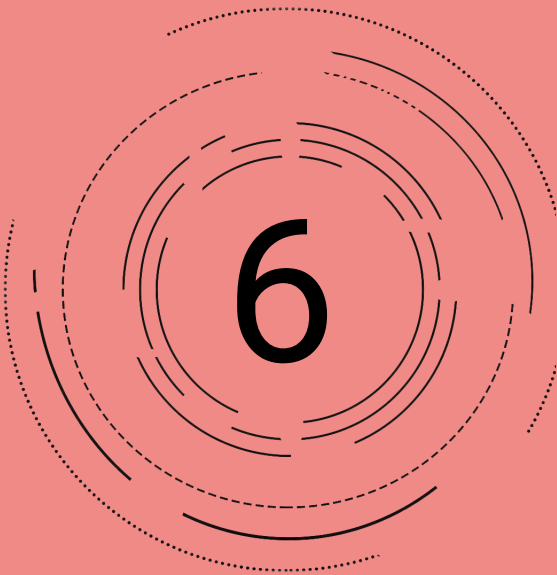


Fig 13: Pre - Hospital Management of Chemical Emergencies drill at NCDC, Delhi.





Responder wearing a Protective Personal Equipment (PPE)



“Preparedness is not a one-time event, it’s an ongoing process”

HOSPITAL PREPAREDNESS AND MITIGATION FOR CHEMICAL EMERGENCY

By the end of this chapter, you will be able to understand:

1. What is Hospital Preparedness?
2. What are the components of Hospital staff Preparedness?
3. What are the steps for Hospital Preparedness for On-site Response during Chemical Emergencies?
4. What is Personal Protective Equipment (PPE) in chemical emergencies management?

6.1 Hospital Preparedness

Mitigating the impact of chemical disasters requires hospitals to address underlying vulnerabilities and proactively enhance resilience to ensure continuity of care. A strong chemical disaster mitigation plan enables healthcare facilities to swiftly activate protocols, minimizing disruptions during incidents. This approach includes strategic placement of first aid and medical treatment areas outside contamination zones, reducing exposure risk for healthcare staff. Medical personnel should ideally operate from designated assembly points where decontaminated patients are brought, with direct entry into hazardous areas reserved solely for critical, life-saving situations. By reinforcing these mitigation measures, hospitals reduce the potential severity of chemical incidents and safeguard the health and safety of both patients and staff. The steps that can be taken for an effective mitigation are as follows:

- **Risk Analysis and Hazard Incorporation**
 - Conduct an annual Hazard, Vulnerability, and Capability (HRVC) analysis, including chemical risks.
 - Identify specific chemical threats within nearby industries and develop risk reduction strategies.
- **Safety and Security Measures**
 - Establish facility security protocols to prevent contamination and protect patients, staff, and the premises.
 - Implement a specialized waste disposal plan for handling chemical waste, ensuring that hazardous materials are properly managed and disposed of.
- **Equipment and Specialized Resources**
 - Equip the hospital with specialized tools and resources for chemical incident management, such as decontamination devices, sealing tape, and all levels of PPE.
 - Laboratory facilities having capacity in the detection of chemicals should be present at higher centres.
 - Allocate suitable evacuation equipment for special needs patients, as well as tools for moving contaminated or decontaminated patients.
- **Infrastructure Design and Allocation**
 - Designate specific wards, operating theaters, and ICU spaces for handling chemical incidents to prevent cross-contamination with general patient areas.
 - Establish both fixed and mobile decontamination units with zones for personnel, equipment, and vehicle decontamination.
- **Access to Essential Medications and Antidotes**
 - Maintain an inventory of critical antidotes and medications specific to chemical exposures.
 - Develop a list of commonly used chemicals in nearby industries and relevant antidotes to address potential chemical exposures promptly.
- **Surge Capacity and Continuity Planning**
 - Plan for surge capacity, including increased staffing, supplies, and spatial needs to accommodate a sudden influx of patients.
 - Develop continuity of operations plans to ensure that critical systems, IT infrastructure, and backups are maintained and operational during chemical incidents.
- **Evacuation and Resource Management**
 - Prepare a comprehensive evacuation plan, including specialized ambulances with resuscitation equipment.
 - Coordinate resource-sharing agreements with neighboring hospitals and health facilities to ensure access to additional personnel, equipment, and supplies.

Refer Annexure 1 for checklist on Hospital infrastructure preparedness for chemical emergencies

6.2 Hospital Staff Preparedness: Planning, Training, and Equipping for Effective Response

Hospital preparedness for chemical emergencies involves developing and implementing plans to respond effectively to chemical incidents. Medical preparedness involves recognizing the effects of chemical accidents and concentrating on public health issues, injuries, and illnesses, including the psychological trauma they cause, are all parts of medical preparedness. Integration of hospital preparedness and public health preparedness to the on site and off site plans is a key in the preparedness process

- **Chemical Incident Response Planning**
 - Maintain a detailed and up-to-date All hazard hospital Disaster Management , which is tested and reviewed annually.
 - Develop and implement notification procedures to alert and mobilize critical infrastructure departments and experts during a chemical incident.
- **Pre-Incident Coordination and Planning**
 - Collaborate with local emergency responders (e.g., fire services, police) to ensure a cohesive approach to chemical incident response.
 - Schedule regular meetings and calls with neighboring hospitals and local agencies to align plans and discuss potential risks.
- **Emergency Medical Team Formation and Training**
 - Form a Emergency Medical Team consisting of trained administrators, physicians, nurses, paramedics, toxicologists and specialists.
 - The lab staff should be specially trained in the collection and handling of the samples of chemical emergency victims.
 - Conduct regular mock drills, focusing on the specific chemical hazards associated with nearby industries.
- **Emergency Communication Protocols**
 - Establish a clear communication protocol, including designating trained communication officers and setting up a dedicated media room for family support.
 - Implement mechanisms to obtain real-time, incident-specific information from local authorities and factories.
- **Training and Awareness Programs**
 - Develop awareness programs for medical and paramedical staff about common chemicals, associated occupational health risks, and preventive or therapeutic measures.
 - Conduct training on recognizing chemical hazards and initial response techniques, including first aid ,triage and immediate management of chemical exposures.
- **Preparedness in Transport and Decontamination Facilities**
 - Designate ambulances and transport services specifically for chemical emergency victims, with paramedics trained in managing exposures.
 - Set up decontamination facilities within the hospital, with permanent/portable units for temporary setups as needed.
- **Resource Inventory and Stockpiling**
 - Conduct routine inventories of critical supplies, including PPE, antidotes, airway management equipment, and essential life saving medications.
 - Stockpile essential resources, including antidotes, PPE, ventilators, and other life-support equipment, to ensure readiness in an emergency.

Refer Annexure 2 for checklist on Hospital Personnel Preparedness



6.3 Hospital Preparedness for On-site Response during Chemical Emergencies

Hospital preparedness and response plans are essential to ensure that healthcare services can be delivered at disaster sites, especially during chemical emergencies. Hospitals and treatment facilities should be equipped to rapidly activate their emergency response systems upon receiving an alert and deploy teams to the field as needed.

- **Risk Assessment:** Conducting a risk assessment of the hospital and surrounding community is crucial to identify potential hazards and likely sites where the emergencies could occur.
- **Provisions for Training Mobile Emergency Medical Team:** A mobile emergency medical team (EMT) should be established, and their roles and responsibilities should be clearly defined. This team should include key staff members from different departments—clinical, administrative, and support staff—ready to provide medical services on the ground at the site. This will not only provide prompt medical care but will also relieve the pressure from the hospital. The capacity of a mobile hospital depends on the magnitude of the disaster and the population to be treated.
- **List of Resources Required:** List of resources required to handle the external disasters Inventory of antidotes, antibiotics, life support mechanisms, oxygen cylinders, continuous positive air pressure (CPAP), ventilators, other prophylactic/therapeutic measures, and medical equipment that needs to be transported on site should be maintained.
- **Pre-Identification of Access Routes:** Routes, alternate routes, and possible diversions to chemical installations or industrial sites must be identified and mapped in advance to facilitate rapid ground access during emergencies.
- **Chemical Incident Information:** Set up mechanism for continuous communication of Comprehensive information regarding the disaster site, type of chemical involved, its properties, and any additional required data must be available to support field operations and inform clinical decision-making.
- **Emergency Field Response Procedures:** Standardized field procedures must be in place for rapid medical response, on-site triage, transport to shelters or medical facilities, evacuation, and both physical and medical rehabilitation and relief.
- **Mutual Aid Agreements:** Pre-established mutual agreements with nearby hospitals and health facilities should be documented, including contact details, to allow for coordinated on-site sharing of resources and manpower when needed.

6.4 Personal protective equipment (PPE)

Personal protective equipment, or PPE, is designed to provide protection from serious injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other hazards. Careful selection and use of adequate PPE should protect individuals involved in chemical emergencies from hazards affecting the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing. No single combination of protective equipment and clothing can protect against all hazards. Thus, PPE should be used in conjunction with other protective methods, including exposure control procedures and equipment. PPE includes overalls, aprons, footwear, gloves, chemical resistant glasses, face shields and respirators.

For first receivers and hospitals, PPE selection is based on the institution's chemical emergency procedures.

- Level A and B PPE is only required for professionals , disaster response forces, HAZMAT teams of industry and fire services responding at the site of disaster and are required to enter the hot zone.
- Level C PPE is usually acceptable -PPE level may need to be upgraded based on scenario
- Post decontamination the Attending medical personnel need only a Level C or D or the COVID PPE kits.

PERSONAL PROTECTIVE EQUIPMENT KIT



Fig 14: PPE Kit



LEVELS OF PERSONAL PROTECTIVE EQUIPMENT



LEVEL A

Level A protection should be worn when the highest level of respiratory, skin, eye and mucous membrane protection is needed.

A typical level A ensemble includes:

- Fully encapsulating chemical protective suit.
- Gloves, inner and outer, chemical resistant and boots,
- Chemical resistant, steel toe and shank; (depending on suit)
- Boot construction, worn over or under suit boot.)
- Self contained breathing apparatus SCBA



LEVEL B

Selected when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection is needed. Minimum level recommended on initial site entries until the hazards have been identified and defined.

A typical level B ensemble includes:

- Chemical resistant clothing (coveralls and long-sleeved jacket, coveralls, hooded two-piece chemical splash suit, Disposable chemical resistant coveralls.)
- Gloves, outer and inner, and boots, outer, steel toe
- SCBA / SAR - supplied air respiratory



LEVEL C

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.

- Full-face or half-mask,
- Air-purifying respirator
- Chemical resistant clothing (one piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls.)
- Gloves, outer and inner
- Boots, steel toe and shank chemical resistant.
- Full face or half mask Air purifying respirator (APR) or Powered air purifying respirator (PAPR)



LEVEL D

Level D protection is primarily a work uniform and is used for nuisance contamination only. It should not be worn on any site where respiratory or skin hazards exist.

Level D assemble requires :

- Coveralls
- Safety shoes/boots.
- Other PPE is based upon the situation (types of gloves, etc.).

Limitations of PPE

1. Safety Hazards:

- Restricted Movement: Health professionals experience limited mobility due to the weight and bulkiness of comprehensive PPE.
- Visual Limitations: PPE, especially face shields and goggles, significantly restrict peripheral vision and the overall visual field.
- Communication Challenges: Effective communication is hindered by masks and face coverings, complicating verbal interactions and reducing clarity.

2. Physiological/Psychological stressors:

- » Psychological Impact: Wearing full protective suits can induce psychological stress.
- » Heat Stress and Dehydration: Extended periods of wearing PPE increase the risk of heat-related illnesses and dehydration due to limited ventilation and excessive sweating.
- » Usage Duration Limitations: The highest protective levels of PPE typically have usage durations

3. Management Requirements:

- Effective Management Program: There is a critical need for structured management protocols to ensure PPE is utilized effectively, safely, and consistently.
- Fit: Physical characteristics like facial hair compromises the airtight seal necessary for masks and respirators, potentially reducing their effectiveness.
- Risks of Improper Use: Incorrect wearing, improper handling, or damage such as penetration or tearing of PPE significantly heightens exposure risk and potential health hazards.

Refer Annexure 3 for Donning and Doffing procedures





NDRF community awareness program at Pune(Maharashtra)



“Advocacy is about creating a sense of urgency and inspiring people to take action”

DECONTAMINATION OF VICTIMS IN CHEMICAL EMERGENCY

By the end of this chapter, you will be able to understand:

1. How to prepare a hospital for decontamination?
1. What is decontamination in a hospital setting?
1. Risk assessment for decontamination

Hospital decontamination in chemical emergencies involves isolating contaminated individuals, performing immediate cleansing to reduce exposure risks, and using triage to separate affected patients from others. Trained staff with protective equipment manage these areas, with protocols to scale up operations if needed. Coordination with environmental authorities ensures safe disposal of contaminated water, protecting both patient and community health.

Patient - Any individual who was at or near the location of a hazardous materials release is potentially exposed and therefore potentially contaminated, hence may require some form of care (e.g., decontamination, lifesaving interventions, antidotal therapy, supportive medical care, communication, or reassurance).

Patient decontamination - Any process, method, or action that leads to a reduction, removal, neutralization - by partitioning or binding or inactivation of contamination on or in the patient in order to: prevent or mitigate adverse health effects to the patient; protect emergency first responders, health care facility first receivers, and other patients from secondary contamination; and reduce the potential for secondary contamination of response and health care infrastructure.

There are four routes by which a substance can enter the body, and accordingly the methods of decontamination change:

1. Skin (or eye) absorption
2. Ingestion
3. Inhalation
4. Injection

7.1 Goals of Patient Decontamination

The main goals of decontamination in chemical emergencies are to protect patient health and ensure safety within healthcare facilities. This involves reducing immediate health risks, preventing long-term effects, protecting staff and infrastructure, and efficiently using resources to help the greatest number of people.

1. Achieve an improvement in patients' acute health outcomes by reducing short-term morbidity and mortality.
2. Achieve an improvement in patients' long-term health outcomes by preventing delayed morbidity.
3. Protect the health and functioning of the health care system by preventing secondary contamination of responders, receivers, and infrastructure.
4. Assure the best health outcome for the most number of affected people and prioritize decontamination

7.2 Preparation for Hospital

At Decontamination stations -No one should enter hospitals without completing decontamination. In cases where contaminated individuals are brought directly to the hospital without prior decontamination on the field, a well-prepared hospital decontamination setup becomes essential.

It is possible that contaminated patients may arrive by their own means, and a decontamination corridor (similar to that of the warm zone, cold zone) will have to be deployed, commonly outside the emergency department or in a previously established area.

The hospital's decontamination plan should incorporate several critical components to ensure safety and efficiency:

A hospital's decontamination plan should include the following critical elements:

- o Are there provisions for preliminary (gross) decontamination of victims until comprehensive decontamination can be completed?
- o Is there a triage protocol to differentiate between contaminated victims and non-contaminated individuals seeking care?
- o Is there a procedure in place to secure the decontamination area?
- o Are there provisions for preliminary (gross) decontamination of victims until comprehensive decontamination can be completed?
- o Is there a triage protocol to differentiate between contaminated victims and non-contaminated individuals seeking care?
- o Is there a procedure in place to secure the decontamination area?
- o Is there a system to ensure that medically qualified, fit-tested personnel are available and designated to wear personal protective equipment and carry out patient decontamination?

- Is there a defined process to determine the appropriate level of decontamination needed, with the flexibility to adjust to changing circumstances?
- Is there a scalable process for expanding decontamination operations to accommodate a large influx of patients, including additional resources (e.g., doffing kits) and the ability to incorporate community decontamination assets when available?
- Is there a process to manage or redirect water runoff for collection and disposal, with coordination from the Environmental Agency, local waste disposal authority, and procedures to notify these authorities appropriately upon activating decontamination measures?

7.3 Risk assessment for patient decontamination

Conduct registration before or after primary triage: Record personal information, Secure and separate personal belongings for potential decontamination

The decision to decontaminate should consider a combination of key indicators, including

- Signs and symptoms of exposure displayed by the patient
- Visible evidence of contamination on the patient's skin or clothing
- Proximity of the patient to the location of the release
- Contamination detected on the patient using appropriate detection technology
- Chemical identity (if known), physical state, characteristics, and behavior
- Entry Control (if detectors available): Those declared "clean" may skip full decontamination,

Patient Prioritization for Decontamination

Prioritize patients by estimating relative risk, grouping into urgent and non-urgent decontamination groups.



7.4 The Steps in Decontamination

- **Conduct Gross Decontamination:** Initiate immediate gross decontamination of victims to mitigate contamination spread until full decontamination procedures can be implemented.
- **Triage and Separate Patients:** Implement a triage process to identify and separate contaminated victims from non-contaminated individuals seeking care.
- **Secure the Decontamination Area:** Establish security protocols to restrict and control access to the decontamination area, ensuring a safe environment.
- **Assign Qualified Personnel:** Ensure that medically qualified and fit-tested personnel, equipped with appropriate personal protective equipment (PPE), are available and assigned to conduct patient decontamination.
- **Determine and Adjust Decontamination Levels:** Continuously assess the level of decontamination required and adapt procedures as the situation evolves.
- **Expand Decontamination Operations:** Scale up decontamination capacity to manage large patient volumes by using additional resources such as doffing kits and integrating community decontamination assets when available.
- **Manage Water Run-Off:** Coordinate with the Environmental Protection Agency and local water authority to contain or divert decontamination water run-off, ensuring proper disposal and notifying relevant authorities upon activation of decontamination operations.

7.5 Decontamination procedures

A tiered approach to patient decontamination allows responders and receivers to base the nature and level of decontamination on the type and extent of contamination, as estimated through a risk-based assessment of the incident, as well as available resources. Note that immediate, lifesaving medical care or antidotal therapy should ideally take priority over decontamination when necessary.

Refer annexure 4 for decontamination of ambulatory and non ambulatory/vulnerable population

Rinse Wipe Rinse Technique

Emergency wet decontamination using the rinse - wipe- rinse technique is simple, effective and requires minimal equipment and training. This technique may be adapted to the situation and available resources. If soap is not available decontamination should still be carried out using water. Similarly if cloths/soft brushes etc., are not available rinsing with water or soapy water is preferable to doing nothing. A specialized decontamination solution may be used if available. Contain all solid waste and water run-off from the decontamination process, where possible. This is important for preventing secondary contamination.

BASIC EQUIPMENT FOR EMERGENCY “ RINSE, WIPE,RINSE” DECONTAMINATION

1. Scissors
2. Buckets (5-10 litres size)
3. Sponges/ soft brushes / washcloths
4. Clean water source (ideally lukewarm water)/ hosepipe for most rinsing; saline solution for wound irrigation, eyes and other membranes; distilled water for mustard if possible.
5. Liquid soap/ washing liquid / shampoo without conditioner
6. Disposable towels / drying cloths
7. Large plastic bags
8. Small clear plastic bags
9. ID / Triage labels / tags / pens
10. Sturdy containers for used decontamination equipments
11. Replacement clothing or sheets / blankets
12. Stretchers



7.5.1 Gross patient decontamination

If a patient is directly referred without undergoing primary decontamination at the field the gross decontamination should be undertaken. Gross patient decontamination is performed with minimal equipment, products, or implements, and can be set up quickly. There should be a Decontamination shower where the victims could be showered. The water after decontamination shower should be collected in separate tank and be treated by biomedical waste management team and not released into common drainage.

Planned and systematic actions, likely to be performed under the guidance of or with the assistance of first responders or first receivers, to achieve contamination reduction to a level that is as low as possible. The patient decontamination tiers are not necessarily a sequential process. They should be applied in a manner that meets the needs of each specific situation.

Patient decontamination is achieved through a well-defined, multi-step process that includes evaluation of the results and, if necessary, repetition of the process. It usually involves a high-volume, low-pressure water shower, with the addition of soap, especially for an oily contaminant, and gentle rubbing with a soft cloth or sponge. The shower may be provided by several different types of equipment or facilities.

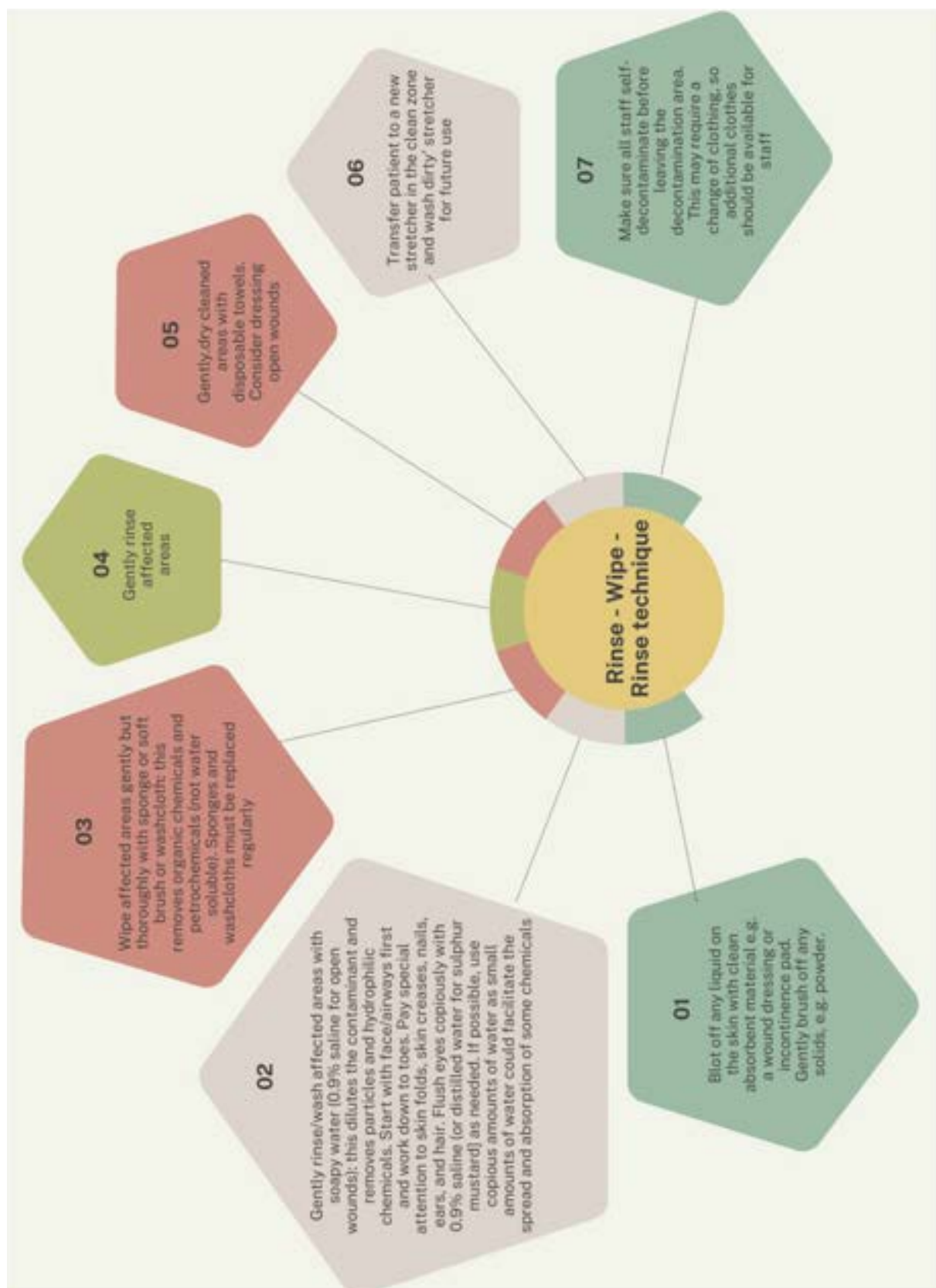


Fig. 15 : Steps of rinse wipe rinse techniques



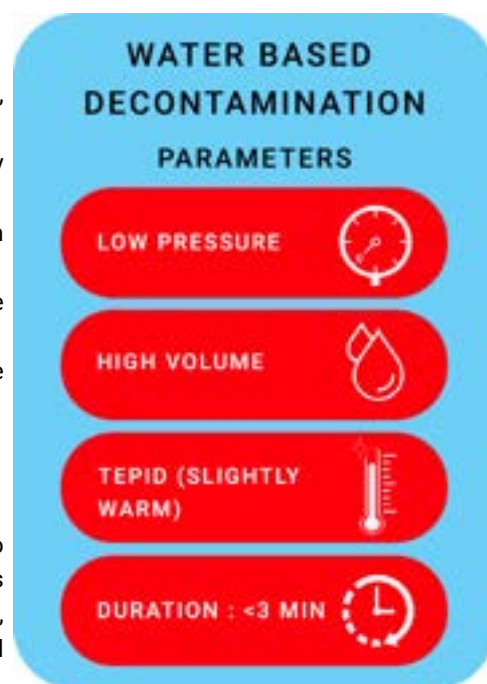
7.5.2 Preferred Decontaminant

- **Preferred Decontaminant:** Water is generally preferred for gross or technical patient decontamination unless the contaminant requires a specific alternative.
- **Additional Tips for Water-Based Decontamination:**
 - Add mild soap if available, especially for contaminants that are thick, oily, or hard to remove.
 - Use a non-abrasive sponge or washcloth to aid in physical removal by gently rubbing contaminated areas.
 - Avoid delaying technical decontamination to acquire specific wash items.
 - Ensure enough wash items are available to prevent reuse and reduce contamination spread.
 - Avoid excessive scrubbing, which could abrade skin and increase chemical penetration.

7.5.3 Alternative Decontaminants

When water-based decontamination is either contraindicated—due to factors such as environmental conditions or the chemical properties of the contaminant—or delayed because of resource constraints, capability limitations, or logistical challenges, alternative practices and

- » Approved neutralizing agents (e.g., partitioning or chelating agents)
- » Chemical-specific agents (e.g., polyethylene glycol for phenolic compounds)
- » Absorbent materials (e.g., spill pads, oil-dry, Fuller's Earth)
- » Adsorbent materials (e.g., activated carbon)



Evaluating effectiveness of Decontamination

Decisions on whether contamination has been reduced to a level that is safe or additional decontamination is necessary can be guided by the following indicators (and others as appropriate)

- Elimination of visible contamination from the skin and/or clothing
- Observable improvement in signs and symptoms which prompted the decision to perform decontamination
- Patient perceptions of the effectiveness of decontamination
- Results from appropriate detection technologies
- If an effective decontamination method, which is known to be appropriate given the nature of the incident and chemical involved, is properly executed, then a sufficient reduction in contamination can be implied.

Note: Immediate, lifesaving medical care and/or antidotal therapy should ideally be a priority, over patient decontamination.

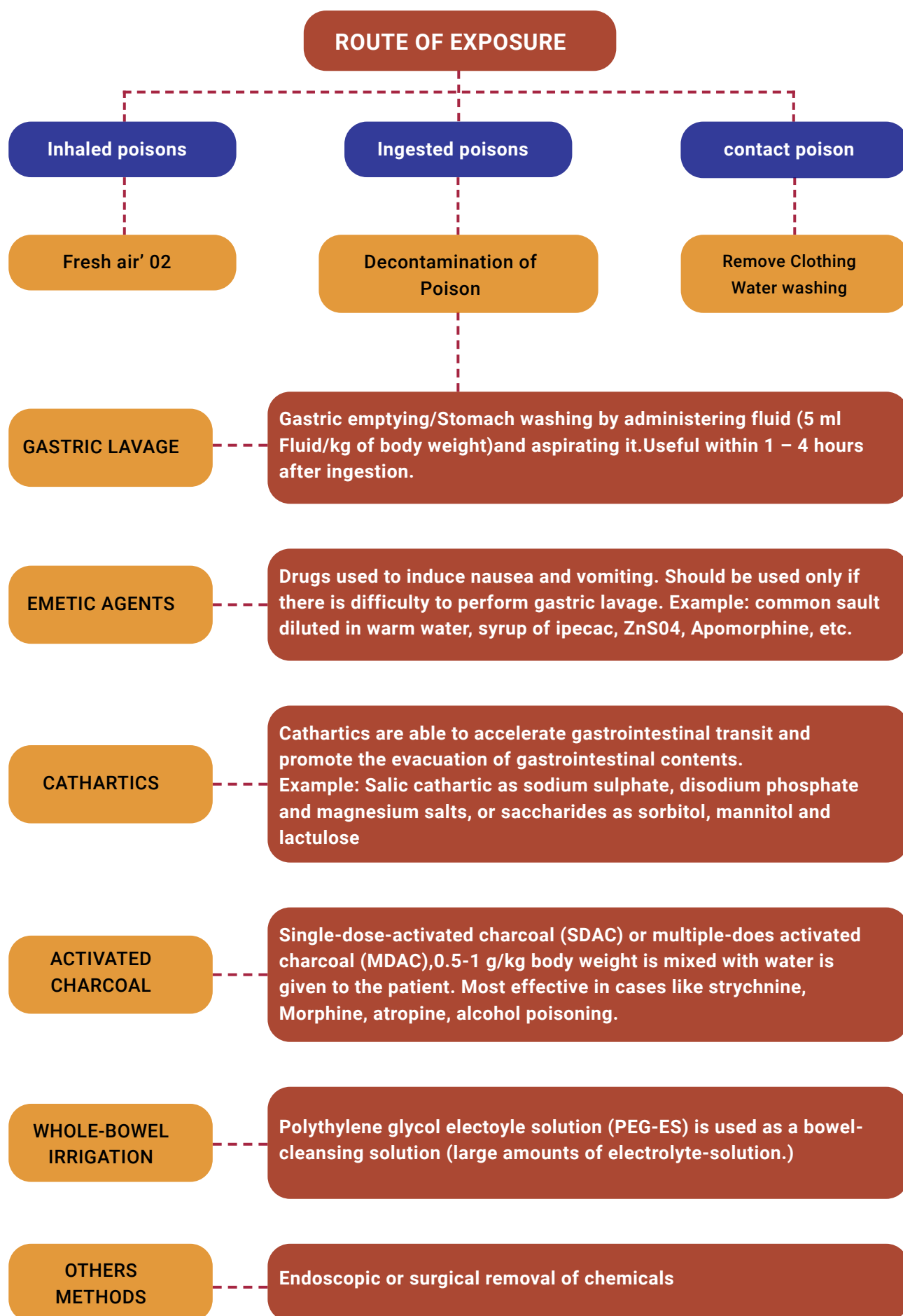


Fig. 16 : Specific decontamination process







"Capacity building is about creating a culture of preparedness and resilience"

HOSPITAL RESPONSE, TRIAGE AND PATIENT FLOW IN CHEMICAL EMERGENCY

By the end of this chapter, you will be able to understand:

1. What are steps in hospital response during a Chemical Emergency?
2. How to do triage in Chemical Emergencies?
3. Patient flow in a hospital during chemical emergency

8.1 HOSPITAL RESPONSE

In the event of a chemical emergency, hospitals play a critical role as frontline responders, tasked with protecting the health and safety of patients, staff, and the surrounding community. Effective response to such incidents requires rapid activation of established protocols, coordinated operations, and vigilant safety measures to minimize exposure to hazardous substances. This chapter outlines essential actions that hospitals must take during a chemical incident, focusing on safety protocols, decontamination procedures, emergency operations, communication strategies, and collaboration with law enforcement. Each action ensures that hospitals are prepared to manage the complex and potentially overwhelming challenges associated with chemical emergencies, prioritizing both immediate and long-term protective measures. Through structured response efforts, hospitals can mitigate risks, preserve vital evidence, and ensure continuity of care, all while maintaining secure and effective operations in the face of a chemical emergency.

1. Ensuring Safety Protocols

- Assess threats from the chemical incident and immediately implement protective measures to safeguard patients, staff, and visitors.
- Activate pre-established safety protocols and communicate these measures hospital-wide.

2. Activating the Emergency Operations Center (EOC)

- Set up the EOC and establish command, ensuring all response activities are directed and coordinated efficiently.
- Assign responsibilities within the EOC and mobilize resources to manage the incident response.

3. Shelter-in-Place and Evacuation Actions

- Shut down HVAC systems immediately to prevent contamination spread.
- Secure all hospital access points and funnel entry through designated secure screening areas.
- Begin evacuation procedures if necessary, ensuring clear instructions and role assignments for staff.

4. Implementing the Decontamination Plan

- Initial triage should be conducted by available medical staff to assign priority for decontamination
- Conduct triage to separate contaminated from non-contaminated individuals, directing them to the appropriate areas.
- Begin initial gross decontamination of affected individuals until full decontamination processes are ready
- Secure the decontamination area with dedicated security personnel.
- Deploy qualified, fit-tested staff to manage patient decontamination.
- Activate expanded capacity as needed to accommodate large numbers of patients, working with community resources.
- Manage water run-off containment and disposal in coordination with local environmental authorities.

5. Resource Inventory

- Perform an inventory check for critical resources such as: Bed availability, Antidotes, Airway management supplies and Critical medications
- Ensure necessary supplies are available and ready for use.

6. Enforcing Chemical Detection and Monitoring

- Use in-house systems or engage pre-identified contacts to monitor chemical levels within the facility and on individuals.
- Maintain a designated contact to coordinate with external monitoring services if necessary.

7. Executing the Communications Plan

- Receive incident updates from field command and communicate them to all relevant teams.
- Provide critical information to decontamination teams, treatment areas, security, and the Hospital Command Center.
- Notify field teams about decontamination sites and emergency routes.
- Coordinate with the local Emergency Operations Center to share operational updates with nearby hospitals.
- Set up a media briefing area and conduct regular updates with local emergency management for the public and press.
- Identify and notify family members of affected patients using established processes.
- Distribute public risk information in alignment with local emergency management guidelines.

8. Engaging Expert Consultation

- Consult with pre-identified experts such as Poison Information Centers and toxicologists for guidance on patient treatment and decontamination procedures.

9. Implementing Security Measures with Law Enforcement Collaboration

- Secure hospital access points to control entry for contaminated and non-contaminated individuals.
- Work with police and agencies to preserve evidence and handle contaminated belongings securely.

10. Preserving Evidence and Managing Contaminated Belongings

- Preserve and handle evidence in collaboration with law enforcement, including the safe transfer of contaminated belongings.
- Follow secure protocols to ensure that contaminated items are processed in accordance with legal and safety standards.

Refer Annexure 5 for checklist on Hospital Response

8.2 Triage of Chemical Casualties

Triage activities should be adapted to the resources available at the healthcare facility and the scale/severity of the event. Triage is a dynamic process, that frequently requires repeat assessments and categorization. The overall picture presented by a range of patients should be considered.

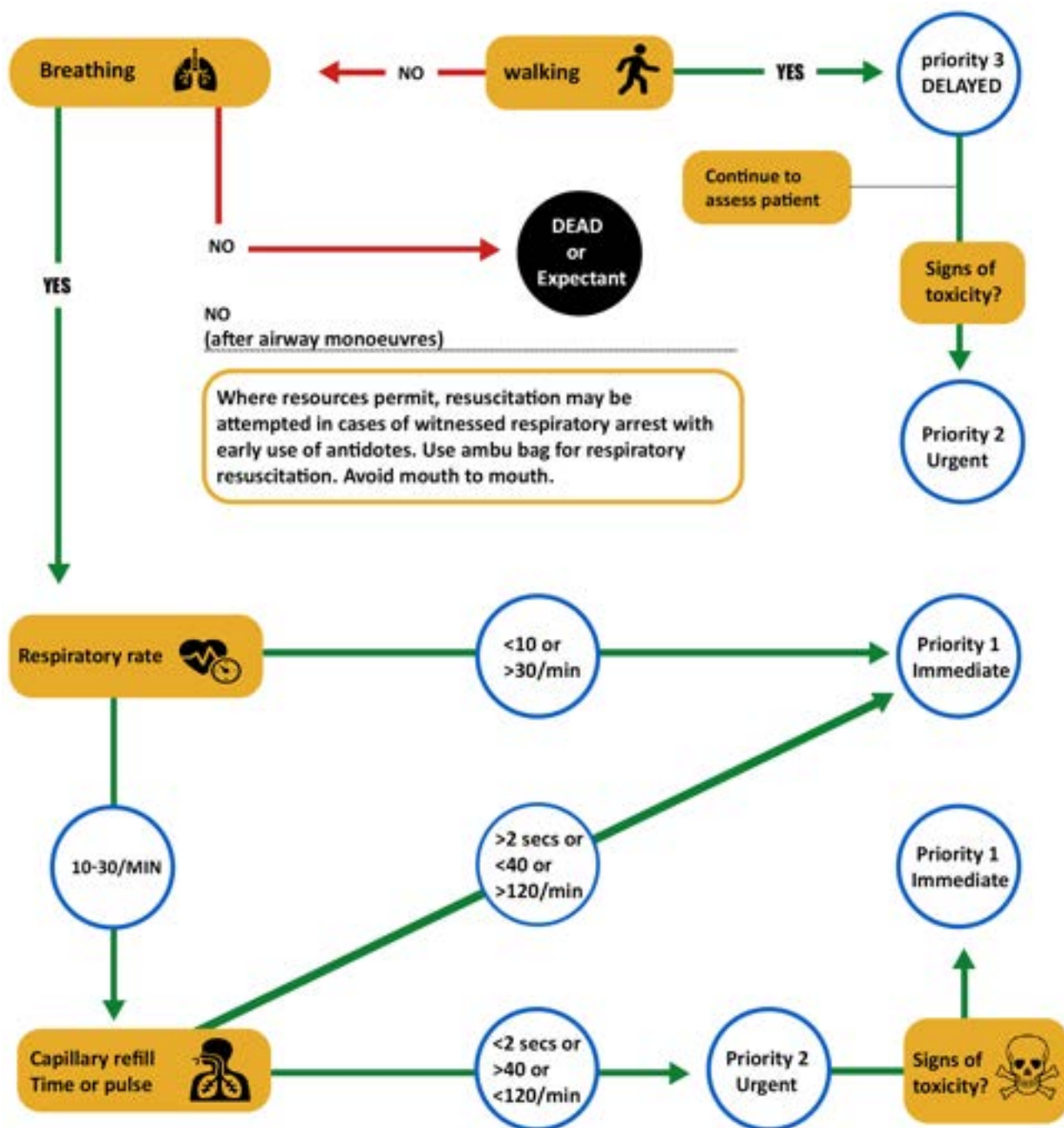
8.2.1 General principles of triage for chemical exposures

- Check triage tag/card for any previous treatment or triage.
- Survey for evidence of associated traumatic/blast injuries.
- Observe for sweating, laboured breathing, coughing/vomiting, secretions.
- Severe casualty triaged as immediate if assisted breathing is required.
- Blast injuries or other trauma, where there is a question on whether there is chemical exposure, victims must be tagged as immediate in most cases. Blast victim's evidence delayed effects such as ARDS, etc.
- Mild/moderate casualty: self/buddy aid, triaged as delayed or minimal and release is based on strict follow up and instructions.
- If there are chemical exposure situations which may cause delayed but serious signs and symptoms, then over-triage is considered appropriate to the proper facilities that can observe and manage any delayed onset symptoms.
- Expectant categories in multi-casualty events are those victims who have experienced a cardiac arrest, respiratory arrest, or continued seizures. Resources should not be expended on these casualties if there are large numbers of casualties requiring care.
- In a given category prioritize a child, pregnant woman over a non-pregnant adult.

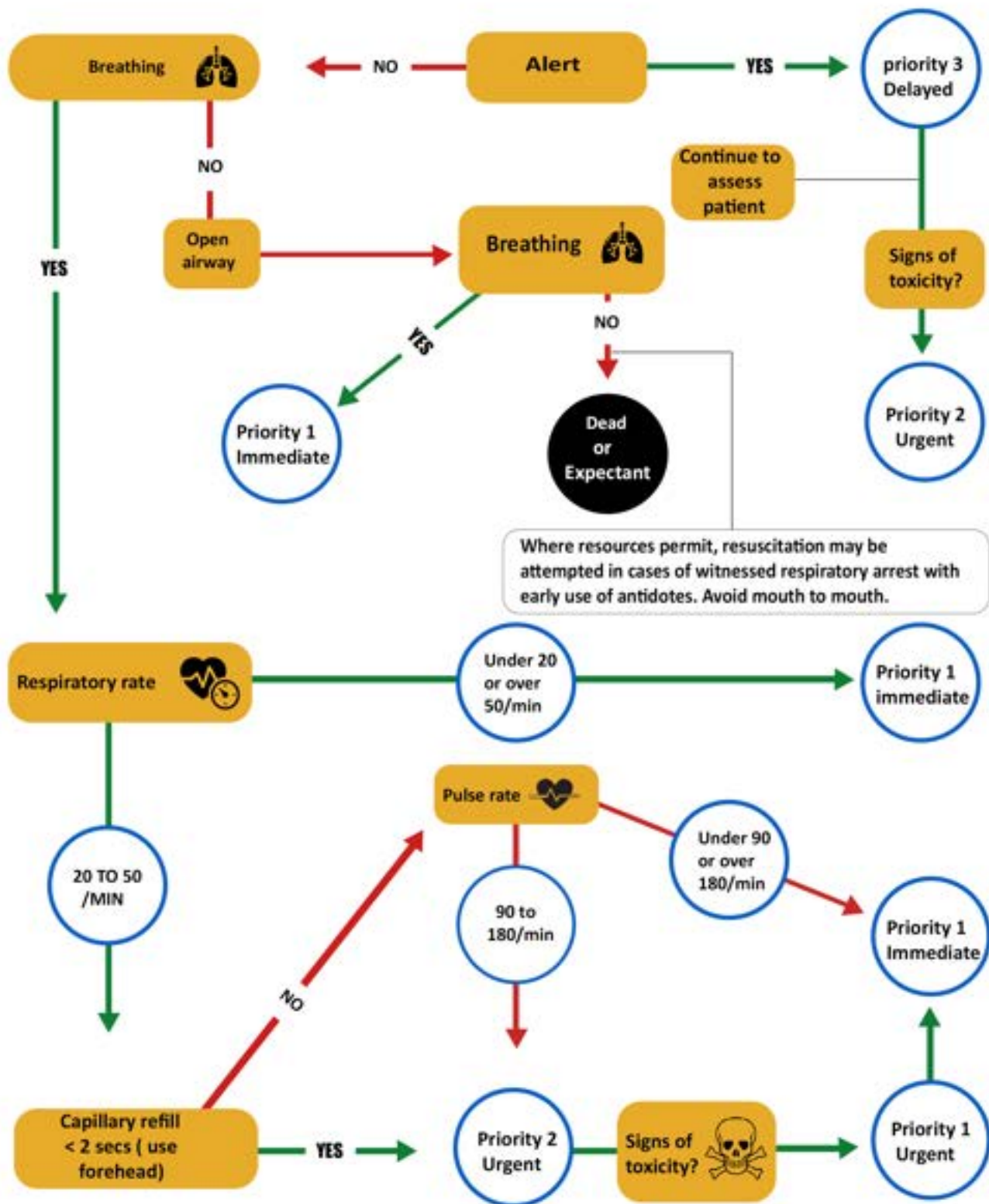
In a chemical incident, asymptomatic patients who have reliable histories and those who experienced only minor sensations of burning of the nose, throat, eyes, and respiratory tract (with perhaps a slight cough) may be released. In most instances, these patients will be free of symptoms in an hour or less. They should be advised to seek medical care promptly if symptoms develop or recur.



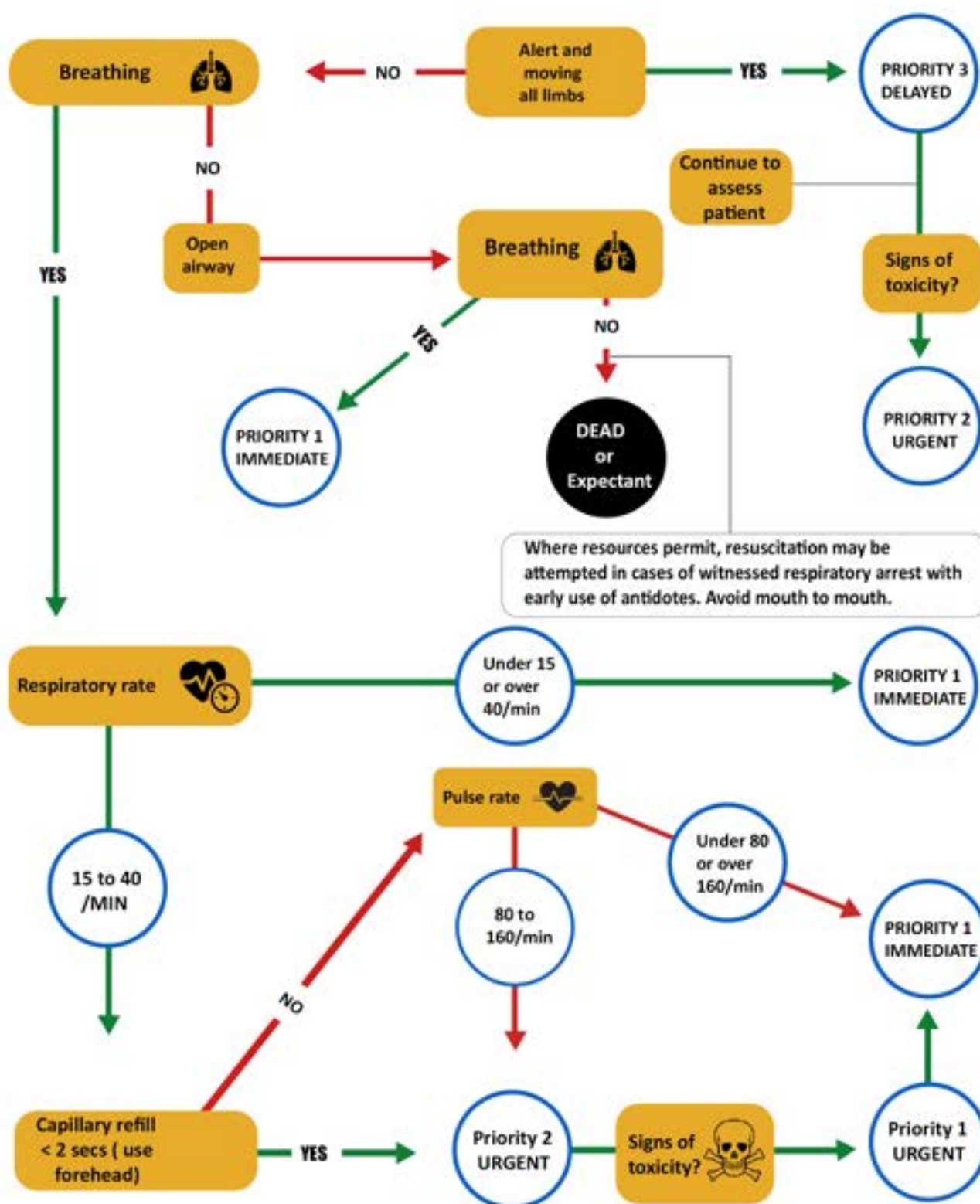
8.2.2 Triage : Adult



8.2.3 Triage : Paediatric 50-80cm (Or 3-10kg)



8.2.4 Triage : Paediatric 80-100cm (Or 11-18kg)

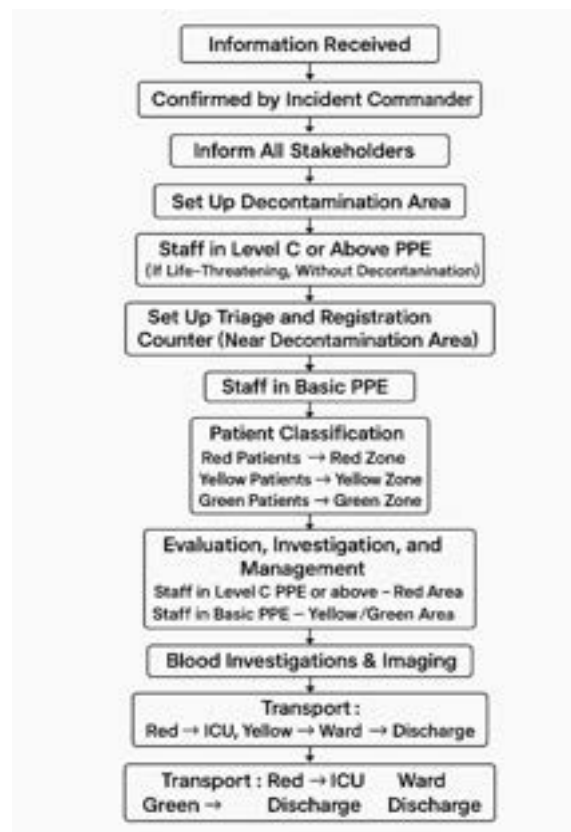


8.4 Patient Flow in the Hospital

In a chemical emergency, patient flow within a hospital is carefully managed to ensure safety and efficiency. Patients arriving at the facility are quickly triaged to assess their condition and any potential contamination. Those affected by hazardous substances are isolated and undergo decontamination to prevent exposure to others. Critical patients receive immediate stabilization in designated areas, while others are directed based on their severity level. Essential diagnostic assessments support decision-making for treatment, admission, or transfer. Throughout this process, clear communication and efficient documentation enable staff to track each patient's status, ensuring organized, timely care. Additionally, discharged patients receive follow-up instructions, while mental health support is offered to address any trauma. This systematic approach helps hospitals manage both individual patient needs and the overall flow in response to the increased demands of a chemical emergency.

8.5 Patient Release

In a mass casualty situation, asymptomatic patients who are reliable historians and those who experienced only minor sensations of burning of the nose, throat, eyes, and respiratory tract (with perhaps a slight cough) may be released. In most instances, these patients will be free of symptoms in an hour or less. They should be advised to seek medical care promptly if symptoms develop or recur.



TRIAGE CATEGORIES

EXPECTANT

- Victim unlikely to survive given severity of injuries, level of available care, or both
- Palliative care and pain relief should be provided

DELAYED

- Victim's transport can be delayed
- Includes serious and potentially life-threatening injuries, but status not expected to deteriorate significantly over several hours

IMMEDIATE

- Victim can be helped by immediate intervention and transport
- Requires medical attention within minutes for survival (upto 60)
- Includes compromises to patient's Airway, Breathing, Circulation

MINOR

- Victims with relatively minor injuries
- Status unlikely to deteriorate over days
- May be able to assist in own care: "walking wounded"



Fig. 14 : Triage tags and bands





"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."

INITIAL MANAGEMENT OF VICTIMS OF CHEMICAL EMERGENCY

By the end of this chapter, you will be able to understand:

1. How to conduct history taking, perform clinical examination and Diagnostic testing in a victim?
2. What is Immediate Management in Chemical Emergencies?
3. What is Specific management in chemical emergencies?

Medical personnel must be well-informed, trained, and experienced enough to quickly assess whether they can manage an incident independently or need additional equipment and specialized personnel. This rapid assessment ensures the appropriate response to potentially complex scenarios involving hazardous substances. Personnel should only attend to the patient after thorough decontamination has been performed. If field decontamination hasn't occurred, trained hospital staff must conduct it before medical care begins. However, in cases of life-threatening injuries (red category), resuscitation may take priority over decontamination. In such instances, healthcare professionals should minimize contact with the patient and use protective gear whenever possible to reduce exposure. Upon receiving an alert about a potential influx of patients from a hazardous incident, hospitals and treatment facilities should immediately activate their emergency plans to prepare for safe and efficient patient management. It is essential that hospitals and response teams are equipped with as much detailed information about the incident as possible, allowing them to tailor their approach to the specific needs of the situation and ensure all necessary precautions are in place.

9.1 Clinical and toxicological information

In the initial management of patients during a chemical emergency, a systematic and comprehensive approach is essential to ensure accurate diagnosis and effective treatment. This process begins with meticulous history-taking, which helps establish the context and possible causes of exposure. Following this, a thorough clinical examination is conducted to assess the patient's current condition and identify any immediate signs and symptoms of toxic exposure. Diagnostic testing then plays a critical role in confirming the presence of specific toxic substances or related biomarkers, guiding the subsequent course of treatment. Together, these steps form the foundation of an effective response to chemical emergencies, ensuring timely and appropriate medical intervention.

Clinical and toxicological information is obtained through three primary methods:

1. **History-Taking**
2. **Clinical Examination**
3. **Diagnostic Testing.**

9.1.1 History-Taking

A diagnosis is predominantly established through comprehensive history-taking. However, there are circumstances in which a patient may present with impaired consciousness (e.g., coma) or altered mental status (e.g., delirium). In such cases, it is imperative to gather history from as many reliable sources as possible, within the constraints of time and available resources.

Potential sources include the patient, family members, rescuers, co-workers, community members, bystanders, public health practitioners, and other healthcare professionals.

- A complete medical history should be obtained for each affected individual.
- Predisposing factors, such as respiratory illnesses, should be identified.
- Open-ended questions are recommended to elicit detailed responses.

Taking a medical history: Questions to be asked

- When did the event(s) occur?
- What events happened at the time of potential exposure?
- What sources are suspected, whether at the workplace or in the community?
- Are there any visible sources of contamination?
- What symptoms were experienced, when were they experienced, and when were they reported?
- What was the latency period between possible exposure and the onset of symptoms?
- What symptoms have persisted?
- Why did individuals attribute their symptoms to a possible exposure?
- Where were you during the time of exposure?
- Were any protective factors present like personal protective equipment?
- Who all have been affected?
- Were any first responders also subsequently affected?
- How many other individuals are affected?
- Were casualties confined to a specific subpopulation, like only specific factory / industrial workers?

9.1.2 Clinical Examination

In cases where a patient presents in a moribund state, the clinical examination should adhere to Nationally approved protocols.

This includes a rapid primary assessment to identify and address airway compromise, ensure spontaneous breathing and adequate circulation, manage any disabilities, and conduct a thorough secondary survey.

Once the patient has been stabilized, or if the patient is stable and alert, a more detailed examination can be conducted to assess clinical signs. There are few clinical signs in toxicology that are truly pathognomonic. Typical clinical features related to exposure to environmental chemicals should be carefully evaluated.

Epidemiological Clue for a chemical Incident

- Clinical course
- Unusual groupings of symptoms and signs
- Signs or symptoms match a recognized toxidrome
- Inconclusive or negative results in diagnostic tests for infection
- No response to usual therapy for infection

Look for symptoms

- Difficulty breathing
- Irritation of eyes
- Sudden headaches
- Tightness of chest
- Loss of coordination
- Nausea , vomiting

Assess

- Type and toxicity of agents,
- Their physical form
- Sites of body exposure
- Intensity of their effects.
- Patterns of casualties
- If the victims showing signs and symptoms of exposure to a hazardous material
- If they have chemical product on them

Patients with drug overdoses or poisoning may initially have no symptoms or they may have varying degrees of overt intoxication. The asymptomatic patient may have been exposed to or may have ingested a lethal dose, but not yet exhibit any manifestations of toxicity.



The presentation of cases with unusual signs and symptoms, particularly to a constellation of features, referred to as a toxidrome, combined with the exclusion of infectious diseases, strongly indicates a potential outbreak of noncommunicable etiology, possibly chemical in nature. Identifying a toxidrome involves synthesizing information from the patient's history, observed clinical features, and any available diagnostic test results, all of which are crucial for confirming exposure to specific classes of chemicals or poisons.

One of the important aspects is the identification of toxidromes in a hazmat incident. The toxidromes are irritant gas, asphyxiant, cholinergic, corrosive and hydrocarbon and substituted hydrocarbon. It would be important to briefly describe each of these.

Refer Annexure 6 on Toxidromes



Toxic syndromes or toxidromes are easily identified with only a few observations. The key data points to determine toxidromes are easily identified:

- Vital signs
- Mental Status
- Pupil size
- Mucous membrane irritation
- Lung exam for wheezes or crackles
- Skin for burns, moistures, and color

Symptoms of some common toxic industrial chemicals

- **Chlorine** - Acute respiratory distress syndrome, bronchospasm, cough, dyspnoea, eye irritation, retro-tracheal pain
- **Carbon monoxide** - Coma, confusion, extrapyramidal features, neuropsychiatric features
- **Dioxins** - Chronic lymphocytic leukaemia, lymphomas, sarcomas
- **Hydrogen sulfide** - Arrhythmia, bronchospasm, confusion, cough, diarrhoea, dyspnoea, eye irritation, neurological features
- **Methyl isocyanate** -Bronchospasm, bronchitis, extrinsic allergic alveolitis
- **Cyanide** - Arrhythmia, coma, fixed dilated pupils, headache, pulmonary oedema, respiratory failure, vomiting
- **Nerve agent** (eg:Sarin)-Bradycardia, diaphoresis, dyspnoea, lachrymation, loss of sphincter control, miosis, muscle fasciculation, muscle paralysis, vomiting, wheeze
- **Vesicants** -Conjunctivitis, blistering, dermatitis, erythema

9.1.3 Clinical Investigations /Diagnostic Tests

General clinical investigations may provide evidence of an effect of exposure to a given chemical(s) on a specific organ without identifying the cause of injury. The common tests include: Full blood counts ,Liver function tests(LFT),Renal function Tests , Serum lectrolytes and electrocardiographic investigations. Poisoned patients may show abnormalities in these investigations, and the results should be interpreted by a suitably qualified clinician.

Clinical and toxicological investigations consist of systematic generation of quantitative or semi-quantitative data for identifying the cause of an incident and improving the specificity of recommended public health control measures. When the exact nature of a chemical of concern is **unknown**, a broad range of chemicals that could conceivably be responsible for the outbreak could be tested. Such “blind” toxicological screening usually requires collection of blood and urine specimens.

Table 10. Samples required for “blind” toxicological screening for an unknown toxicant (60)

In order of importance, the samples for blind toxicological screening should consist of:	
Adults	• 10 mL blood in plastic (polypropylene) lithium heparin tube • 5 mL blood in glass^a lithium heparin tube • 10 mL blood in plastic (polypropylene) EDTA-coated tube • 30 mL urine without preservative
Children	• 5 mL blood in glass^a lithium heparin tube • 5 mL blood in EDTA-coated tube • 30 mL urine without preservative

EDTA, ethylene diamine tetra-acetic acid

^a If glass tubes are unavailable, polypropylene tubes may be used.

Biomarkers are biological characteristics that are measured objectively and evaluated as indicators of normal biological or pathological processes. They may be used to determine whether the chemical exposure has caused cell, tissue or clinical injury.

- o **Biomarkers of exposure:** Measurement of the contaminant itself, a metabolite or the product of interaction between a xenobiotic agent and some target molecule or cell.
- o **Biomarkers of effect:** A measurable biochemical, physiological, behavioral or other alteration that indicates an established or possible health impairment or disease
- o **Biomarkers of susceptibility:** Indicators of an inherent or acquired ability of an organism to respond to the challenge of exposure to a specific xenobiotic substance.

The primary objective of laboratory analysis of clinical and environmental samples is to identify the presence and nature of toxic substances, metabolites, or biomarkers that are pertinent to the investigation of the outbreak. Laboratory investigations should be targeted and, whenever possible, informed by the results of epidemiological and clinical assessments. Non-specific or random testing of human and environmental samples should be avoided, as it is generally inefficient and consumes significant resources.

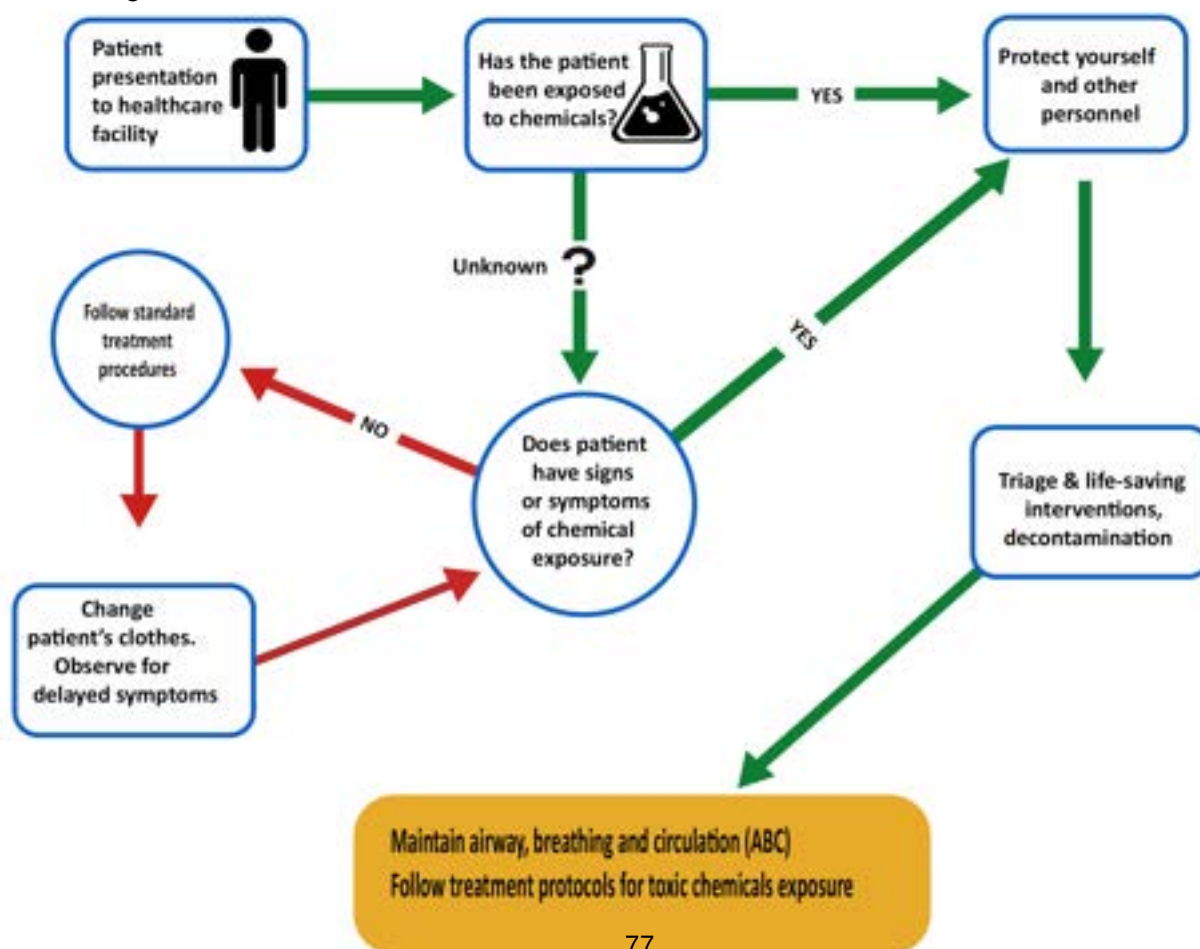
9.2 Immediate Management

Patients who have experienced exposure to chemicals can present with a wide range of symptoms, from being completely asymptomatic to displaying various degrees of symptoms. It is important to recognize that even an asymptomatic patient may have been exposed to or ingested a potentially lethal dose, and the absence of immediate symptoms does not rule out the risk of toxicity. In cases where patients exhibit symptoms, the immediate priority is the treatment of any life-threatening complications, rather than an exhaustive diagnostic evaluation.

For patients presenting with mild symptoms, it is crucial to understand that their condition can deteriorate rapidly. Therefore, any exposure that is potentially significant should be closely monitored in an acute care setting to ensure prompt intervention if the situation worsens. The specific complications that may arise depend on the type and severity of the chemical involved and necessitating vigilant observation and readiness to respond to evolving clinical needs.

9.2.1 Initial Management

Initial Management of Patients Flowchart



Assess the Danger Assessment will usually consider the dose ingested; the time since ingestion; the presence of any symptoms or clinical signs; preexisting cardiac, respiratory, kidney, or liver disease; and, occasionally, specific serum drug or toxin levels. Be aware that the history given by the patient or family may be incomplete or unreliable. Observation of patient Asymptomatic or mildly symptomatic patients should be observed for at least 4–6 hours. Longer observation is indicated if the ingested substance is a sustained-release preparation



CENTRAL NERVOUS SYSTEM

Seizures

Hyperthermia

Cyanide / Nerve Agents

BZ / Agent 15

EYE, NOSE AND SKIN

Constricted Pupils

Dilated pupils

Dry mouth and skin

Eye Irritation

Blistering of skin

Cyanosis

Nerve agent / opioids

Nerve agent / cyanide

BZ / Agent 15

Blister agents / Riot / control agents (RCAs) / Lung irritants

Blister agents

Cyanide

RESPIRATORY TRACT

Asphyxiation

Copious secretions

Delayed respiratory distress

Delayed pulmonary oedema

Cyanide

Nerve Agents

Blister Agents

Lung irritants

DIGESTIVE TRACT

Nausea

Diarrhoea

Lung irritants / RCAs / Incapacitating agents / cyanide

Nerve Agents

MUSCULOSKELETAL

Fasciculations

Nerve Agents



Fig 17 & 18: Mock drills in NCDC, New Delhi



9.3 Specific Management in Chemical Emergencies

9.3.1 Chemical Burn

In the event of a chemical burn, the first priority is to decontaminate the affected individuals as quickly as possible to prevent further injury. The following flow- chart outlines the general steps for managing a mass casualty incident involving chemical burns :



Fig. 19 : Flow chart of Mass casualty management of chemical burns

9.3.2 Poisoning

In the event of a poisoning incident, the first priority is to identify the type of poison involved and administer the appropriate antidote if available. The following flowchart outlines the general steps for managing a mass casualty incident involving poisoning:

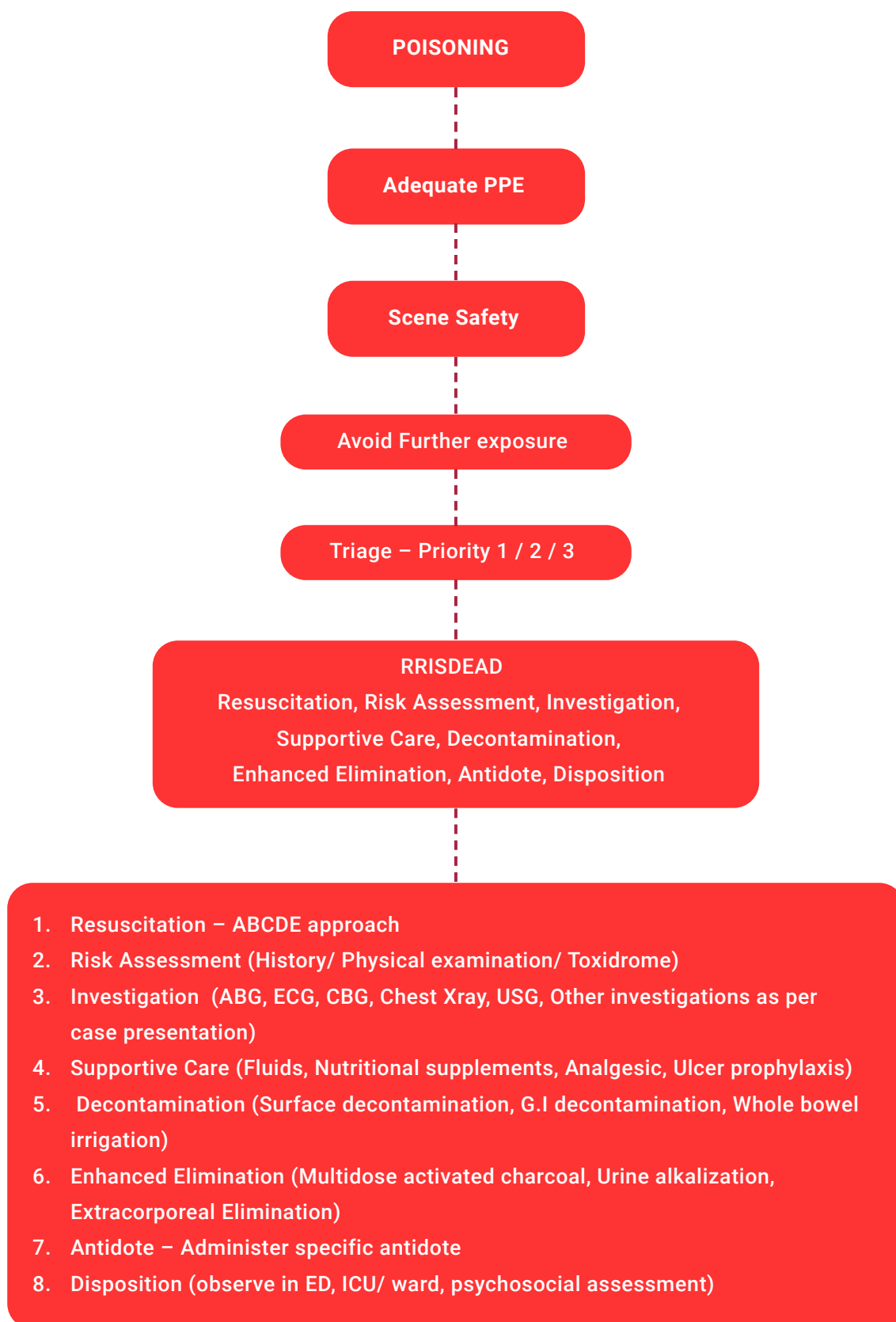


Fig. 20 : Flow chart of Mass casualty management of poisoning



9.3.3 Gas Leak

In the event of a gas leak, the first priority is to evacuate the affected area and provide immediate medical attention to individuals who have been exposed to the gas. The following flowchart outlines the general steps for managing a mass casualty incident involving a gas leak

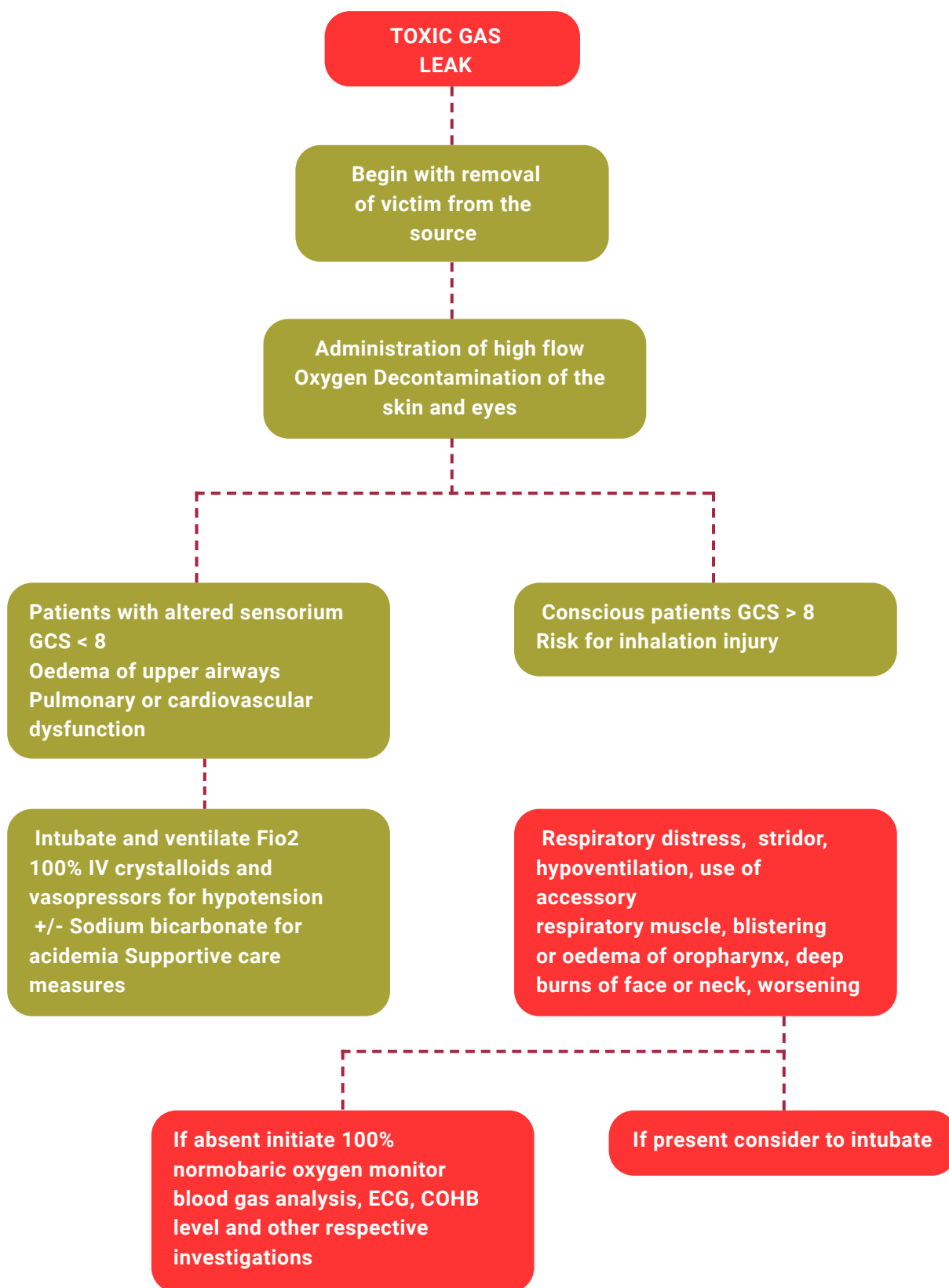


Fig. 21 : Flow chart of Mass casualty management of chemical burns

9.3.4 Management with and without antidote

In some cases, an antidote may be available to counteract the effects of a toxic substance. In these situations, it is critical to administer the antidote as soon as possible. The following flowchart outlines the general steps for managing a mass casualty incident involving a toxic substance, both with and without an antidote

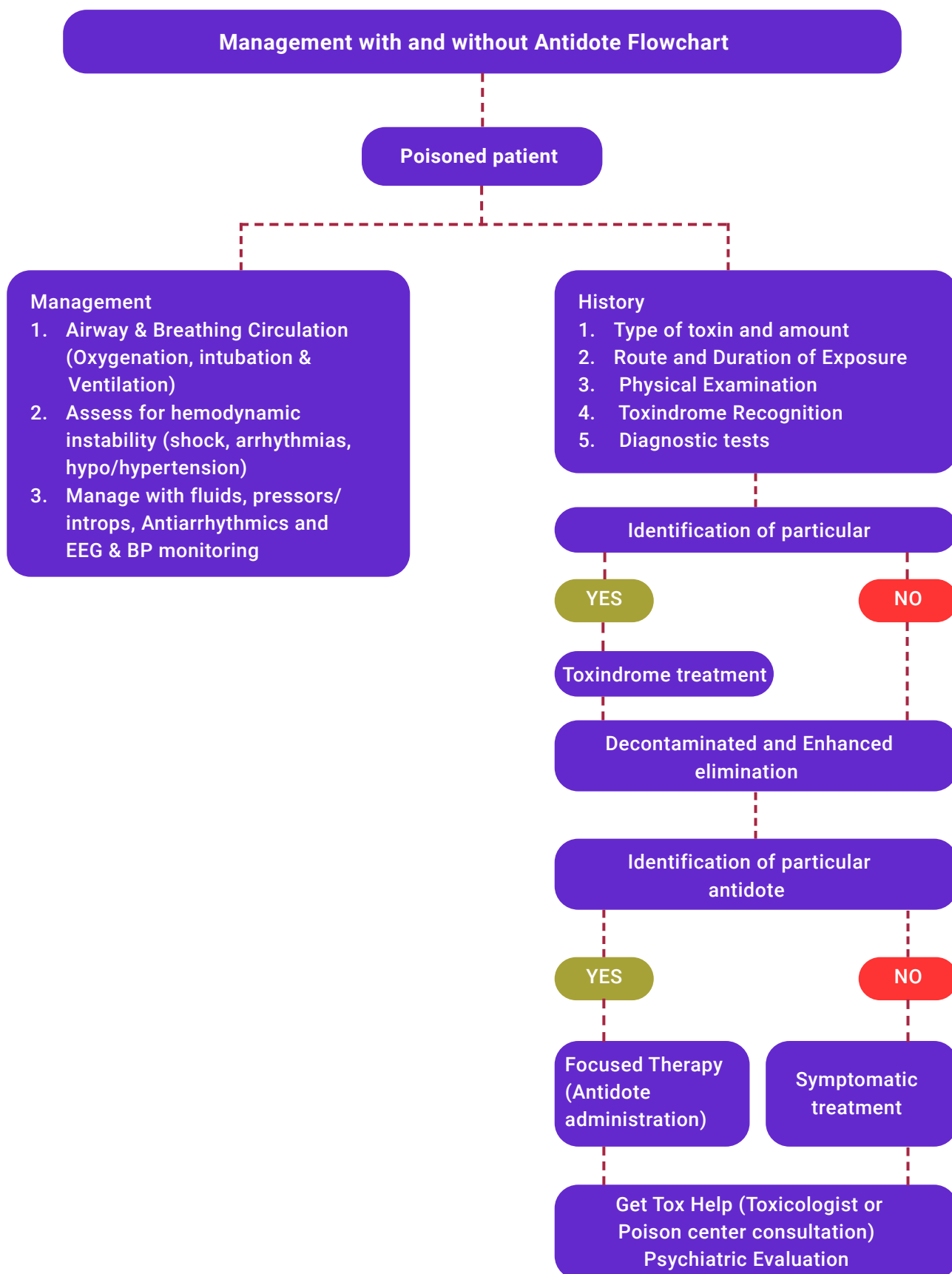


Fig. 22 : Flow chart of Mass casualty management of chemical burns



HIGH RISK TOXIC INDUSTRIAL CHEMICALS

Ammonia	Hydrogen chloride
Arsine	Hydrogen cyanide
Boron trichloride	Hydrogen fluoride
Boron Trifluoride	Hydrogen sulphide
Carbon disulphide	Nitric acid
Chlorine	Phosgene
Ethylene oxide	Phosphorus trichloride
Fluorine	Sulfur dioxide
Formaldehyde	Sulfuric acid
Hydrogen bromide	Tungsten hexafluoride

National Disaster Management Guidelines—Management of Chemical (Terrorism) Disasters, 2009.
A publication of the National Disaster Management Authority, Government of India.
ISBN 978-81-906483-9-4, June 2009, New Delhi.

CASE STUDY 2 :

EXPLOSION AT THE CHEMICAL INDUSTRIES OF ETHYLENE OXIDE (IQOXE) SITE IN TARRAGONA, CATALONIA, SPAIN 1995

The IQOXE plant in Tarragona, suffered a large explosion on 14th of January 2020. It occurred in the ethylene oxide tank and the transformation station. Two people were killed, one by a missile fragment from the explosion inside his flat in Torreforta about 2.5km away, one IQOXE employee working on site. A second IQOXE employee died as a result of his injuries one day later in hospital. Missile fragments also damaged neighboring plants in the industrial area of Tarragona. The explosion happened at the end of the production of a batch of MPEG 500, an ethoxylation derivative used as an additive for cement. A 500-metre (547 yd) exclusion zone was imposed; railway lines and a highway were closed.

Lessons learned

- Location of control room Risk should be at a safer location.
- Assessment of fire hazard associated with ethylene oxide
- Risk-appropriate fire detection and mitigation systems
- Post the disaster IQOXE site is classified as an 'upper tier' establishment under the Seveso Directive (2012/18/EU), meaning they have to comply with the strictest safety regime required by the Directive.





Firefighters try to douse a fire, that broke out in a chemical factory of Deepak Nitro Company, at Nandesari GIDC in Vadodara, 2022



"Medical management is not just about treating illness or injury, it's about restoring health and well-being."

SURGE CAPACITY AND MASS CASUALTY MANAGEMENT

By the end of this chapter, you will be able to understand:

1. What is Hospital surge capacity planning?
2. What is zone designation during mass casualty management?

In events such as chemical disasters, the risk of mass casualties rises sharply, potentially overwhelming health systems due to the sudden influx of affected individuals. Medical facilities, regardless of size, may find it challenging to cope with this rapid increase in demand, emphasizing the need for resilient health systems that can handle such surges. Preparation should begin at the ground level, with first responders and designated on-site managers. They need to be aware of the mass casualty potential to avoid overloading the system. First responders must prioritize victim care through effective triage and patient flow management. Coordinated efforts with ambulance services are essential to ensure smooth operations.

To evenly distribute patients across public and private medical facilities, authorities must establish standard operating procedures, a clear command chain, and mechanisms for sharing information between hospitals. This enables efficient patient allocation based on hospital capacity and patient condition, enhancing patient flow management. Pre-existing agreements between hospitals are crucial for effective patient load distribution, preventing individual facilities from becoming overwhelmed.

10.1 Hospital Surge Capacity Planning:

To meet the demands of chemical disasters, health systems must implement strategies to scale up hospital capacity, encompassing space, staff, and supplies. Planners should devise strategies for the efficient direction of resources and public movements post-incident to ensure medical needs are safely met. If a hospital lacks capacity for chemical cases, protocols should direct immediate referral to designated facilities. Key elements of surge capacity management include:

- **Facility Planning:** Hospital construction should include plans for areas that can be scaled up during emergencies.
- **Equipment Readiness:** Identified hospitals must be equipped with detection, protection, and decontamination equipment.
- **Dedicated Resources:** Specific beds should be reserved for emergency purposes, following strict isolation and air barrier protocols.
- **Disaster Victim Identification:** Hospitals should have facilities for identifying and managing deceased individuals.
- **Resource Requirements:** Determine essential resources and identify readily available sources.
- **Communication Protocols:** Develop communication protocols for timely updates between government and hospitals and among hospitals for ongoing situational awareness.
- **Pre-Disaster Agreements:** Establish contracts and memoranda of understanding (MoUs) to facilitate resource and staff sharing between hospitals during a chemical emergency.
- **Public Messaging:** Formulate strategies to guide patient movement and prevent hospital congestion due to unwarranted fears.
- **Temporary Facilities:** Identify and plan areas for setting up temporary hospitals and decontamination units during emergencies.

These preparations and strategies for surge capacity management are vital for ensuring health systems can respond effectively to chemical disasters, maintaining patient care standards, and preventing healthcare infrastructure from becoming overwhelmed.

10.2 Zone Designations during Chemical Mass Casualty

In a mass casualty event, the ordinary Emergency Department (ED) setup is typically inadequate to handle the surge of patients, as the scale of incoming casualties surpasses routine capacity. To manage this influx effectively, hospitals should implement a designated zone system that categorizes spaces based on the severity and needs of patients. Zone designations, such as triage, red zone, green zone and decontamination areas, allow for organized patient flow, ensuring that critical cases receive immediate attention while minor injuries are directed to less intensive care zones. By expanding beyond the traditional ED layout, zone designations provide structure, helping medical teams manage patient load, prevent bottlenecks, and optimize resource allocation to save more lives in crisis situations.

1. Triage Area

- **Purpose:** The Triage Area serves as the initial assessment point where patients are classified based on the severity of their conditions.
- **Location:** This area should ideally be situated just outside the Emergency Unit but positioned close to the Red Zone entrance. This proximity allows for immediate transfer of critically injured patients to the Red Zone on hospital stretchers.
- **Flow Control:** From the Triage Area, patient flows should be distinctly diverted to designated zones:
 - **Green Zone:** For non-critical cases.
 - **Red Zone:** For critical cases requiring immediate medical intervention.
- **Access Control:** Family members and media should be directed to avoid this area to reduce congestion and maintain focus on patient care.

2. Green Zone

- **Purpose:** The Green Zone is for patients with non-critical injuries or those classified as low priority during triage. It serves as a holding area where these individuals receive basic care or wait for further assessment.
- **Optimal Location:** The Green Zone should ideally be a part of the hospital outside of the main Emergency Unit, such as an Outpatient Department (OPD), hospital lobby, or cafeteria. Using such areas helps in maintaining the integrity of the Emergency Unit while keeping non-critical patients away from high-intensity care areas.
- **Configuration and Flow:**
 - **Separate Entrance and Exit:** A designated entrance and exit for the Green Zone, if possible, to avoid interference with other zones.
 - **Direct Path to Red Zone:** A secure and direct pathway for patient transfer from the Green Zone to the Red Zone if their condition worsens.
 - **Facilities:** This zone should be equipped with a waiting room for patients and preferably located indoors to avoid exposure to outdoor elements unless no other option is available.
- **Patient Transfer:** Ensure a method for safe patient transfer to the Red Zone on stretchers if their condition escalates.

3. Red Zone

- **Purpose:** The Red Zone is the Emergency Room (ER) itself, designated for critically injured or severely ill patients who require urgent, high-priority treatment.
- **Configuration Requirements:**
 - **Resuscitation Area:** A designated open space within the Red Zone where multiple resuscitation teams can operate simultaneously. This space should accommodate the maximum number of teams with extra capacity for newly arriving critical patients.
 - **Specialized Equipment and Fittings:** The area must be equipped to handle chemical incidents, including specialized flooring and equipment to support chemical decontamination and prevent contamination spread.
- **Centralized Coordination:** Avoid dispersing patients across multiple rooms within the Red Zone. Keeping patients centralized allows the Coordination Lead (CL) to oversee and manage all cases effectively.
- **Buffer Zone:** Identify a nearby buffer or “pick-up” area for patients needing evacuation to wards or further treatment areas.

4. Media and Family Management

Location Management: To ensure operational efficiency and maintain patient privacy, media personnel and family members should ideally be directed to areas away from the Triage and flow lines of both the Red and Green Zones. There should be a Separate Media waiting room and A Family rom This reduces the risk of congestion and keeps the focus on patient care without unnecessary external distractions.



	Designation	Location	Type of patient	Capacity	
				Bed	Equipment
1	Arrival/ reception area		Contaminated		
2	Decontamination Area		Contaminated		
3	Triage area		Decontaminated		
4	Yellow/ Green patient treatment Area		Decontaminated		
5	Red patients treatment Area		Contaminated/ Decontaminated		
6	Doffing area		Decontaminated		

10.3 Job Cards for Chemical Emergency Roles

1. Incident Commander

- Assume the role of IC, overseeing all activities.
- Supervise security arrangements.
- Identify media personnel and coordinate briefings, inform bystanders, and manage patient arrival lists.
- Oversee logistics management.
- Ensure all actions align with the Chemical Contingency plan/Disaster management plan of the hospital.
- Maintain a roster of doctors and staff throughout the emergency.

2. Communication in charge /Telephone Operator

- Verify the identity of the informant in a CBRN disaster.
- Notify the ED in charge/ED focal point immediately.
- Record response times accurately for all involved parties.
- Participate in post-chemical incident disaster debriefing

3. Nurse Coordinator (Chemical emergency focal person)

- Notify the Telephone operator.
- Instruct caller to divert ambulances to the hospital 's CBRN receiving area.
- Inform relevant specialists: SR (Emergency Medicine, Trauma Surgery, Ortho, Neurosurgery and other relevant)
- Notify: Nursing supervisor on duty, All ED nurses: off-duty nurses remain on standby
- Notify Operating Theater (OT), Blood Bank, ICU, Radiology, and Lab.

4. Triage in Charge

- Wears the Appropriate PPE
- Moves to the triage point
- Responsible to deploy Triage Kit at the triage point
- Performs Step 1 triage of each casualty
- Sorts casualties into non-walking and walking categories
- DOES NOT leave the triage area at any point during MCI unless replaced

5. Duty doctors in Emergency Department (Emergency Medicine, Trauma Surgery, Ortho, Neurosurgery, Plastic/Burns Surgeon)

- Report to the Incident Commander.
- ED doctor in charge acts as team leader until IC arrives.
- Trauma, Ortho, and Neurosurgery SRs support ED in charge .
- Allocate manpower and resources as per plan.
- Ensure readiness of equipment in triage, receiving, and disaster areas.

- Arrange for patient relocation from Red Area to Yellow Area/ICU.
- Confirm PPE availability for staff in triage/receiving/disaster zones.
- Assign tasks to SRs, JRs, and nursing/HA staff as per plan.
- Supervise patient management and documentation.
- Identify patients in ICU/wards for possible discharge.
- Update on-call faculty about the situation.
- Request additional SRs if needed from department heads.

6. Registration Desk

- Register all patients entering the earmarked CBRN.
- Conduct hourly checks to ensure all patients are accounted for.
- Register unidentified patients as “unknown” if unaccompanied.
- Notify: Nursing supervisor on duty, All ED nurses: off-duty nurses remain on standby
- Notify Operating Theater (OT), Blood Bank, ICU, Radiology, and Lab.

7. Faculty on Call (All Departments)

- Arrive at the Emergency Department and report to the Incident Commander.
- Assess departmental staffing and recruit additional staff if needed.
- Discharge patients from ICU/wards if feasible.
- Assemble OT teams as required.

8. Resource Lead (ED Nurse)

- Ensure the Disaster Almirah is always stocked.
- Ensure specific PPEs/Hazmat kits are available for CBRN emergencies.
- Report to the Emergency Department and the Incident Commander.
- Verify ED staffing, mobilizing surge staff if needed.
- Check medical and surgical supply levels.
- Direct nurses and Sanitation workers to designated areas.
- Confirm the availability of trolleys and wheelchairs.
- Coordinate ED activities and staffing during the disaster.

9. Nursing Staff

- Perform routine patient care tasks.
- Assist in relocating Red Area patients to wards, ICUs, or Yellow Area.
- Ensure disaster area equipment is logged and remains within the designated area.

10. Blood Bank

- SR Lab Medicine assists with blood product coordination in relocating Red Area patients to wards, ICUs, or Yellow Area.

11. Security Staff

- Direct ambulances to CBRN designated hospital entry points.
- Manage bystander movement.
- Handle patient valuables securely.

12. OT Technician

- Ensure monitors, suction devices, and ventilators are ready in the Disaster Area.
- Organize additional equipment as needed.
- Check availability of ventilator air filters.
- Prevent equipment movement between contaminated and non-contaminated areas.

13. Sanitation Worker

- Collect and securely seal patient clothes /discharges in appropriate BMW bags

14. Mortuary

- Allocate a separate space for disaster-related bodies, isolated from other bodies.



10.3.1 Staff Deployment during Chemical Emergency

	Doctor	Nurse	Tech	Attendant	Security	Cleaning	PPE Level
Decon Area	-		-	X	-	X	C and Above
Triage	X/-	X	-	X	X	-	
Green	X	X	X	X	X	X	D
Yellow	X	X	X	X	X	X	D
Red	x	X	X	X	X	X	C and above (If contaminated patient)

CASE STUDY 3 :

SANDHURST CHEMICAL BLAST , UNITED KINGDOM

On October 30, 2000, a waste management and recycling company in Sandhurst, Gloucestershire, United Kingdom a fire broke out accompanied by little explosions. They was storm and heavy rain making it difficult for the fire department to get to the scene. The Residents in the vicinity were evacuated. The fire was put out only in late evening . Tons of dangerous chemicals, including asbestos, insecticides, solvents, and cyanide stored in drums, were destroyed in the fire. The River Severn flooded, covering the waste disposal plant up to 2.4 meters below the surface. It was stated that chemicals leaked into the floodwaters from the location. For several days, the site was inaccessible due to flooding, which hindered the prompt evacuation of hazardous materials. Up until the end of November, the location was seriously threatened by water, and in December, it flooded once more. Before the water receded, all materials could not be cleaned up. In order to evaluate the effects of the catastrophe on the community, local health officials conducted health surveys in response to the high number of illnesses that were reported in the days that followed the fire and the flood. Locals reported experiencing breathing difficulties, stinging eyes, and sore throats as health impacts. Health officials declared that there was no proof of potential food contamination hazards or long-term repercussions on public health.

Lessons Learned

- Plant located at flood prone areas
- No pre prepared plan for removal of chemical materials in case of emergencies or accidents
- Explosion and fire can be devastating effects of chemical emergencies.
- The follow-up response to a chemical incident should include a long-term health assessment if appropriate





Pharma manufacturing factory blast, Chandapur, Sangareddy district 2024



"Failing to prepare is preparing to fail."

REHABILITATION

By the end of this chapter, you will be able to understand:

1. What is rehabilitation in chemical emergencies

11.1 Rehabilitation

Rehabilitation is defined as “a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment.” It encompasses efforts to restore and enhance the physical, psychological, and social health of people or groups affected by medical conditions, crises, or disasters. A chemical disaster can significantly disrupt multiple aspects of individual health and well-being. Rehabilitation after chemical accidents can be a prolonged and challenging process, often requiring a multidisciplinary approach that includes medical, psychological, and social support.

Activities involved in the rehabilitation should address:

- Health Care: Includes surveillance for delayed onset of diseases and provision of health services with specialized care tailored to the unique needs of victims, along with treatment for injuries related to the incident.
- Chemical Residuals: For certain chemicals, such as toxic metals that remain in the body, appropriate treatment modalities like chelation therapies or interventions to facilitate chemical metabolism are necessary.
- Monitoring for Long-term Effects: If exposure levels are uncertain or long-term effects are unclear, extended monitoring should be conducted.
- Psychological Support: Incidents that may pose minimal physical risk can still cause significant psychological stress. Psychological support is essential to address the emotional and mental health impact of chemical accidents. Stress can often be alleviated through clear communication regarding measures taken to minimize community exposure.
- Social Support: Includes assistance with financial and legal issues, as well as support in finding employment and housing.
- Quality of Life: Restoring recreational facilities, such as parks, cinemas, theaters, and sports facilities, is essential to enhancing quality of life.

Guidelines for Rehabilitation from Common Chemical Injury Types:

- Severe Burns: Rehabilitation from chemical burns may involve wound care, skin grafting, and positioning and splinting techniques to support skin healing, reduce swelling, and restore movement.
- Chemical Exposure: Rehabilitation from chemical exposure may include decontamination, supportive care, and medications to counteract toxic effects.
- Disability: Rehabilitation for disabilities resulting from chemical accidents may involve physical therapy, occupational therapy, and assistive technology.
- Psychosocial Issues: Rehabilitation for psychosocial issues may include counseling, therapy, and medication. A supportive and understanding environment is crucial for individuals coping with psychological effects from chemical accidents.

Although the critical role of rehabilitation in emergencies is recognized in clinical and humanitarian guidelines, it is often overlooked in health system preparedness and early response planning. This omission can exacerbate limitations in rehabilitation services, reduce the efficiency of health service delivery, and increase the risk of long-term impairment and disability among those affected.

In all cases, rehabilitation from chemical accidents may require a sustained commitment to medical and psychological care. Close collaboration with healthcare professionals, social workers, and other support services is essential to achieve the best possible outcomes for affected individuals.

CASE STUDY 4 :

AKSA ACRYLIC FIBRE PLANT CHEMICAL SPILL, TURKEY AUGUST 1999

On 17 August 1999 in Kocaeli, Turkey, a powerful earthquake (magnitude of Mw 7.4) occurred. This area is heavily industrialized and densely populated, and the consequences of the earthquake were severe. Over 15 million people were affected, with over 17 500 fatalities and 44 000 injuries.. The earthquake caused numerous events including an acrylonitrile spill at the AKSA acrylic fibre plant in Ciftlikkoy, one of the largest acrylic fibre production facilities in the world. Acrylonitrile was released into containment dykes and into the air. Damage to the dykes resulted in seepage of the chemical into the soil, contaminating an aquifer and subsequently through the drainage channel into the sea. Damage to the roads following earthquake meant that emergency response was paralysed. The efforts to stop the leak took 40 hrs. animals, birds and vegetation within a 200 m radius and close to the houses and settlements around the tanks died. Some members of the emergency-response teams showed signs of toxicity, as did members of the public living in the vicinity. Reported health effects included hoarseness, vertigo, nausea, respiratory problems, skin irritation, headache, and eye and nasal irritation. Local hospitals and clinics were overcrowded with seriously injured people. They were not able to provide adequate treatment to chemically-exposed people, in part because the lack of telecommunications meant that experts at the AKSA facility could not be contacted about the toxicity of acrylonitrile and the management of exposure.

Lessons Learned

- Hazard vulnerability and risk should be done before the construction of the industries
- Adequate information sharing between the industrial plants and medical facilities to help better response and management.
- The follow-up response to a chemical incident should include a long-term health and Environmental assessment if appropriate.



ANNEXURE

ANNEXURE 1: Hospital Infrastructure Preparedness Checklist

Hospital Infrastructure Preparedness Checklist (Including Planning)

1. Safety Protocols

- Is chemical risk included in the hospital's annual Hazard and Risk Vulnerability Analysis (HRVA)?
- Are nearby industrial hazards mapped and analyzed for response implications?
- Are strategies and tactics to mitigate chemical risks clearly identified and implemented?
- Are protective measures such as PPE, decontamination zones, and barriers available and accessible?

2. Chemical Incident Planning

- Is there a comprehensive, up-to-date Disaster Plan?
- Is the plan reviewed and tested annually with lessons learned integrated?
- Does the plan include incident activation triggers, response flowcharts, and escalation protocols?

3. Notification & Activation

- Are there clear procedures to notify critical departments (e.g., ER, ICU, Pharmacy, Security) during a chemical incident?
- Is there a system to activate HIRS
- Are automated messaging systems in place for rapid staff mobilization?

4. Emergency Operations Center (EOC)

- Is there a designated physical space to set up an EOC during chemical emergencies?
- Are key EOC roles assigned and trained in advance?
- Are communication tools (radios, phones, internal alert systems) available and functional?

5. Evacuation and Shelter-in-Place Plans

- Are evacuation routes clearly mapped for staff, patients, and visitors?
- Are shelter-in-place zones designated and known to staff?
- Can HVAC systems be shut down quickly during an incident?
- Are access points securable to limit air exchange or unauthorized entry?

6. Decontamination Infrastructure

- Are decontamination tents, showers, or areas available and in working condition?
- Is there a secure and accessible location for decontamination activities?
- Can decontamination capacity be expanded during large-scale incidents?
- Is coordination with local authorities in place for containment and disposal of runoff water?

7. Chemical Detection and Monitoring

- Are gas detectors, contamination meters, or other monitoring systems available?
- Are protocols in place to detect and respond to chemical contamination inside the facility?
- Is there a contact or partner agency for specialized chemical detection services?

8. Communication Systems

- Is there a plan to receive real-time updates from local authorities or field units?
- Are communication systems in place to update hospital command, decon teams, and staff?
- Are staff and visitors quickly notified of evacuation or shelter-in-place decisions?
- Is there a media briefing area and plan for external communications?

9. Security Measures

- Is hospital security trained and prepared to manage access during chemical events?
- Are contaminated and non-contaminated zones clearly separated and guarded?
- Are procedures in place to support law enforcement with evidence preservation?

10. Specialized Equipment and Resources

- Are sufficient PPE supplies available across all levels (gloves, suits, masks, boots)?
- Are stretchers, wheelchairs, and other transport tools ready for contaminated patients?
- Is equipment available for bariatric and special-needs patients during evacuation?
- Are sealants, tapes, and decon tools available for rapid containment?

11. Logistics -PPE, Medications, Antidotes and other supplies

- Are relevant antidotes for common industrial and chemical exposures stocked?
- Is there a list of chemicals in nearby industries and associated medical countermeasures?
- Are stockpiles available for 48–72 hours of high-volume patient care and Surge staff needs
- Are ventilators, IV fluids, airway kits, and antidotes stored securely but accessible

12. Response Planning

- Does the hospital have a comprehensive and updated Chemical Incident Response Plan?
- Is the plan tested through annual drills and inter-agency simulations?
- Are dedicated family rooms and registration stations available for emergencies?
- Is there a system to track bed availability and other critical surge resources?
- Does the hospital have a comprehensive and updated Chemical Incident Response Plan?
- Is the plan tested through annual drills and inter-agency simulations?
- Are dedicated family rooms and registration stations available for emergencies?
- Is there a system to track bed availability and other critical surge resources?

ANNEXURE 2: Hospital Personnel Preparedness Checklist

1. Training and Safety Protocols

- Train personnel regularly on chemical hazard identification, risk assessment, and safety protocols.
- Assign and train staff responsible for regularly updating hospital safety procedures.
- Establish a multi-disciplinary Chemical Emergency Response Team

2. Emergency Operations Center (EOC) Staffing

- Clearly designate and train personnel for EOC roles and responsibilities.
- Conduct regular emergency management coordination and communication skills training for EOC staff.
- Is there a system to activate HIRS
- Are automated messaging systems in place for rapid staff mobilization?

3. Training and Awareness

- Are regular chemical hazard awareness sessions conducted for all hospital staff?
- Do staff receive scenario-based training /TTX /Drills on various scenarios related to chemical accidents

4. Evacuation and Shelter-in-Place Drills

- Regularly conduct evacuation drills involving all hospital staff.
- Train staff in rapid shelter-in-place procedures, including HVAC shutdown and securing access points.

5. Triage

- Are triage staff trained to identify and separate contaminated patients?
- Personnel trained in managing rapid emergency registration?
- Security staff briefed on controlling patient flow

6. Decontamination Team Training

- Maintain an adequately trained and fit-tested team for patient decontamination processes.
- Conduct security training in securing decontamination areas.
- Train decontamination team members trained in PPE use and health monitoring

7. Chemical Detection and Monitoring Training Chemical Detection and Monitoring

- Provide ongoing training for staff on operation of chemical detection equipment and interpretation of results.
- Designate and train staff contacts for liaison with chemical detection service providers.

8. Communication Roles and Training

- Train personnel responsible for internal and external dissemination of critical incident information.
- Assign and train a dedicated family-notification team for emergencies.

9. Security

- Conduct regular training sessions for security personnel in managing patient influx and facility security.
- Train personnel in collaborating with law enforcement on evidence management and patient interviewing procedures.

10. Coordination with External Agencies

- Regularly engage staff in collaborative preparedness meetings and exercises with external emergency agencies (fire, police, neighboring hospitals).



11. Specialized Equipment and Medication Training

- Ensure personnel familiarity and training on specialized equipment handling
- Conduct ongoing medical staff training on chemical-specific antidotes and medications.

12. Surge Logistics and Resource Management

- Are logistics staff trained in supply chain continuity and emergency procurement and emergency pre authorization to emergency supplies?
- Are personnel assigned to maintain and update inventories (antidotes, PPE, medications)?

13. Incident Response Drills and Exercises

- Regularly conduct comprehensive chemical incident preparedness drills
- Evaluate and provide feedback to personnel after preparedness exercises and drills.
- Train staff in accessing and utilizing chemical-specific incident information from local authorities or responding agencies.

14. Mock Drills and Simulations

- Are chemical-specific mock drills conducted at least twice a year?
- Are after-action reviews performed with improvements fed back into planning?



ANNEXURE 3: Donning & Doffing Procedures

Donning of Level C PPE kit

- Personal Protective Equipment (PPE) Acquisition
- Secure the appropriate PPE as recommended by the Casualty/Emergency Department (ED) in charge. Wear a scrub suit instead of regular clothes to help regulate body temperature.
- Remove all jewelry and leather items and place them in a labeled plastic bag. Hand over to Security for safekeeping.
- Secure long hair using a hairnet or tie it in a braid.
- Hydrate with a glass of water before donning PPE.
- If time permits, record baseline vital signs (BP, pulse, respiratory rate, and temperature) on the Medical Surveillance form.
- Collect PPE components: appropriate-sized chemical protective suit, APR-Respirator, and 2–3 compatible cartridges (usually HEPA/organic vapor).
- Lay out PPE and inspect each item for size and functionality.
- Assemble and check all PPE components, including properly fitted APR with HEPA/organic vapor cartridges; avoid overtightening and ensure pull-tabs are removed.
- Don inner and outer gloves, foot protection, and chemical suit, seal all interfaces with duct tape, confirm full coverage with no exposed skin, and perform respirator seal check.
- For chemical exposure, wear one pair of nitrile gloves over the inner gloves, followed by one pair of butyl rubber gloves.
- Have a second person conduct a safety check to confirm all PPE is properly secured.

Doffing of Level C PPE kit

- Wash hands thoroughly.
- While still wearing PPE, wash your body starting from the top of the head down to the boots. Have a partner assist in washing your back.
- Loosen the tape on boots and gloves, but do not remove them yet.
- Unlock and remove the respirator, and place it on a clean surface such as a chair, gurney, or the floor.
- Carefully remove the outer suit by rolling it inside-out away from your body, with assistance. Remove outer gloves simultaneously with the suit.
- Take off the respirator hood and dispose of it properly.
- Step out of the boots and suit into the final rinse area, keeping inner gloves and underclothing on. Wash and rinse thoroughly with a partner's help.
- In cold weather, remove the inner suit and discard it appropriately.
- Remove nitrile gloves by partially rolling down one glove, then sliding your thumb under the second glove to remove both at once.
- Wash again, remove base clothing, then exit the decontamination area and wrap in clean towels or blankets.

ANNEXURE 4: Patient Decontamination Procedure (to be done only by trained professionals and Specialized teams)

Ambulatory Victims

- Direct the patient to the Decontamination Sector. Whenever possible, children should stay with their parents. If no parent or older sibling is available, a Decontamination Team member should assist the child.
- Instruct the patient to promptly remove all clothing, placing valuables in the clear plastic bag and clothing in the larger bag. Both bags should then be placed into the third bag and securely sealed with the numbered tag provided in the kit.
- Place the sealed clothing bag in a secure holding area and record the patient's name and tag number in Record. The patient should then proceed into the Decontamination Sector.
- Begin with a quick head-to-toe rinse. Instruct the patient to wash using soap and a washcloth or brush, starting with any open wounds, and then continuing from head to toe in a systematic manner.
 - Wash for 5 minutes if the contaminant is known to be non-persistent, or for 8 minutes if the agent is persistent or unknown.
 - Do not scrub too vigorously.
 - If eye irritation is present, apply a topical anesthetic before irrigation.
- Decontamination Team members must carefully observe each patient to ensure thorough cleansing, paying close attention to the axillae, body folds, creases, and hair. Assistance should be provided as needed.
- Following the wash, the patient should perform a final rinse
- All used soap, washcloths, brushes, and sponges must be discarded in a designated trash receptacle and must not enter the Cold Zone.
- After rinsing, the patient should move to the drying area, dry off completely, and discard the towel in the designated contaminated waste bin.
- Once dry, the patient should wear a clean patient gown and proceed to the Triage Area.
- Additional medical interventions should be limited to those considered lifesaving by the Decontamination Officer and Antidotes should only be administered intramuscularly (IM) after the affected area has been cleaned.
- Decontamination Team members should remain vigilant for signs of clinical deterioration among ambulatory patients. Any patient who becomes non-ambulatory should be immediately transferred to the Non-Ambulatory Sector using a backboard, stretcher, or wheelchair.

Non Ambulatory Victims

- The patient should be brought to the Decontamination Sector and attended to by at least four Decontamination Team members. Two members will be responsible for turning the patient on the backboard, and one will maintain cervical spine precautions, if needed.
- Position the patient on a backboard, ensuring that any padding is removed.
- Carefully remove all clothing. Valuables should be placed in the clear plastic bag and clothing in the larger bag. Both bags should then be sealed within a third bag using the numbered tag provided in the kit. Clothing may be cut away if necessary.
- To reduce the aerosolization of particulate contaminants, clothing should be turned inside out during removal. The skin should be gently dabbed with sticky tape or vacuumed to eliminate any surface particles.
- Attach the numbered clothing bag tag around the patient's neck. This tag should remain in place throughout the decontamination and subsequent treatment process.
- Store clothing bags securely. If staff are available, record the patient's name and tag number in the Patient Decontamination Record.
- Position the patient on a backboard with support. Perform an initial rinse from head to toe using a handheld sprayer, garden hose, or showerhead. Take precautions to prevent aspiration of the rinse water.
- Clean the patient with soap and a washcloth or brush, beginning with the airway, then any open wounds, followed by a systematic head-to-toe wash.
 - Wash for 5 minutes if the agent is non-persistent, or for 8 minutes if the agent is persistent or unknown and Avoid vigorous scrubbing or rubbing of the skin.
- To cleanse posterior surfaces—such as the back of the head and neck, back, buttocks, and legs—gently roll the patient onto their side with the assistance of 2–4 team members, while maintaining spinal precautions when necessary.

- Ensure thorough cleaning of body creases and cavities, including the ears, eyes, axillae, and groin.
- If eye irritation is present, a topical ocular anesthetic may be used to aid in effective eye irrigation.
- Perform a final rinse from head to toe over approximately one minute, using techniques that minimize the risk of recontamination

(Ref: Occupational Safety and Health Administration (OSHA), 2005. Best Practices for Hospital-Based First Receivers of Victims from Mass Casualty Incidents Involving the Release of Hazardous Substances. Washington, D.C.: U.S. Department of Labor.)

ANNEXURE 5: Hospital Response Checklist

1. Chemical Incident Plan Activation

- Activate the Chemical Incident Plan/Contingency Plan.
- Review and follow protocols for decontamination, triage, and patient care.

2. Safety Protocols

- Immediately assess threats from the chemical incident.
- Activate hospital-wide safety protocols for patients, staff, and visitors.
- Issue appropriate PPE to all response personnel.
- Inspect hospital environment (air, water, surfaces) for contamination.
- Implement containment strategies as required.

3. Emergency Operations Center (EOC)

- Set up and activate the EOC.
- Assign incident command roles (medical, logistics, communication, etc.).
- Ensure communication tools are functioning for real-time updates.

4. Shelter-in-Place and Evacuation

- Shut down HVAC systems to prevent chemical spread.
- Secure all hospital access points and funnel entry through screening zones.
- Implement shelter-in-place or activate evacuation plan if necessary.
 - Confirm evacuation routes for patients and staff.
 - Designate evacuation leaders and ensure proper communication.

5. Decontamination Procedures

- Establish decontamination zones before patient intake.
- Begin gross decontamination immediately.
- Triage to separate contaminated from non-contaminated individuals.
- Deploy trained, fit-tested personnel with full PPE.
- Manage water run-off in collaboration with environmental authorities.

6. Chemical Detection and Monitoring

- Use internal detection systems to monitor contamination levels.
- If unavailable, contact pre-identified external monitoring services.

7. Communications Plan

- Activate internal communications for seamless information flow.
- Provide regular updates to EOC, decontamination, and clinical areas.
- Notify field command of decon sites and emergency access routes.
- Coordinate with local EOC for updates and neighboring hospital support.
- Set up a designated media briefing area
- Identify and notify family members of affected patients.
- Disseminate public safety messages in line with official guidance.

8. Security Measures

- Secure facility entrances and exits.
- Control influx of contaminated/non-contaminated individuals.
- Coordinate with law enforcement to: Preserve evidence, manage and safely store contaminated belongings, identify possible perpetrators among the injured.

9. Secondary Site Readiness

- Activate backup care facilities or expansion sites.
- Prepare for patient transfer and service continuity if primary site is overwhelmed.



10. Notification Procedures

- Notify relevant infrastructure departments, public health experts, and regulators.
- Alert first responders and neighboring hospitals for coordinated response.

11. Access to Incident-Specific Information

- Establish channels with local authorities and industries to obtain chemical-specific data.
- Share critical chemical exposure data with relevant departments.

12. Emergency Registration and Patient Tracking

- Implement a rapid patient registration process.
- Ensure proper tracking and documentation of all incoming patients.

13. Resource Inventory and Supply Readiness

- Conduct a real-time inventory of critical supplies: Beds, Antidotes, Airway management tools, Emergency medications
- Ensure ready access and functionality of all essential equipment.

14. Family Rooms and Support Areas

- Set up safe and separate spaces for family members.
- Provide continuous updates and psychological support services.

15. Expert Consultation and Clinical Support

- Engage toxicology and Poison Information Centers for guidance.
- Ensure clinicians have immediate access to antidote protocols and expert advice.

ANNEXURE 6: Toxidromes

Quick look at toxidromes

	Nerve Agent	MethHb	Cyanide/HS	Pulm Agents	Vesicant/acid/alkali	Atropine	Botulinum	Opiate
RESPIRATION	↑↑	↑	↑↑/↓	↑↑	↑	↑	↓	↓
PUPILS	Pinpoint	N	N/dilated	N/ed	N/ed	Dilated	Dilated	Pinpoint
SKIN	Sweaty	Cyan	Pink or cyan	Cyan	Red (delayed)	Dry	Dry	N
SECRECTIONS	↑↑	N	N	↑	N/↑	↓	↓	N
OTHER	Fasciculation Fitting	Chocolate blood	Sudden onset	Pink sputum	Mustard (delayed)	Confused	Descending paralysis	↓GCS

Pulm Agent = Pulmonary Agent

Cyanide/HS = Cyanide/Hydrogen Sulfide

Met HB formers = Nitrites and other TICs

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Factsheet : Chemical Emergencies

Key Points

PREVENTION OF CHEMICAL EMERGENCIES



SAFE LOCATION OF CHEMICAL FACILITIES

Ensure chemical facilities are situated away from residential areas.

REDUCTION OF STORED TOXIC AND FLAMMABLE CHEMICALS

Implement measures to reduce the quantity of stored toxic and flammable chemicals

TECHNICAL CONTROLS AND REDUNDANCY

Incorporate technical controls to enhance the safe use of chemicals

PREPARATION FOR MANAGEMENT OF CHEMICAL EMERGENCY

SCENARIO ANALYSES AND IMPACT ASSESSMENT

Conduct scenario analyses to identify potential chemical release scenarios

PLANNING, TRAINING, AND EXERCISING RESPONSE

Develop comprehensive emergency response plans

TRAINING AND EQUIPPING RESPONDERS

Ensure responders are well-trained to handle loss of containment situations



DETECTION AND ALERT IN CASE OF CHEMICAL EMERGENCY

EARLY RECOGNITION OF CHEMICAL EVENTS

Develop systems for early detection of chemical events

SCALING UP INCIDENT RESPONSE

Establish protocols to scale up the incident response based on the severity of the chemical event

RESPONSE IN CASE OF CHEMICAL EMERGENCY

CONTAINMENT OF CHEMICAL RELEASE

Act promptly to contain the spread of the released chemicals

DECONTAMINATION

Implement decontamination procedures for affected areas and individuals

MANAGEMENT OF HEALTH CONSEQUENCES AND RISK ASSESSMENT

Provide medical care and support for individuals affected by the chemical release



RECOVERY IN CASE OF CHEMICAL EMERGENCY



RISK AND IMPACT ASSESSMENT

Assess the overall risk and impact of the chemical release

CLEAN-UP

Execute thorough clean-up operations to remove residual chemicals and contaminants.

INVESTIGATION OF ROOT CAUSE

Investigate the root cause of the chemical release

WHY IS THIS IMPORTANT?

A chemical incident is the unexpected release of a substance that is (potentially) hazardous either to humans, other animals or the environment. Chemical releases arise from technological incidents, impact of natural hazards, and from conflict and terrorism. The management of chemical incidents requires a multi-disciplinary and multi-sectoral approach - the health sector may play a supporting or a leadership role at various stages of the management.

WHAT ARE THE HEALTH RISKS?

Chemical incidents can cause injury through four basic injury mechanisms which can also be strongly interrelated:

- Fire produces injuries through heat and exposure to toxic substances (including combustion products).⁶
- Explosion produces traumatic (mechanical) injuries through the resulting shockwave (blast), fragments and projectiles.
- Toxicity may result when humans come into contact with a chemical released from its containment, be it from storage or transport, or as reaction or combustion products. Toxicity can cause harm by a wide array of toxic mechanisms ranging from chemical burns to asphyxiation and neurotoxicity.

KEY FACTS: INDIA

India has witnessed the world's worst chemical (industrial) disaster "Bhopal Gas Tragedy" in the year 1984. The Bhopal Gas tragedy was most devastating chemical accident in history, where over thousands of people died due to accidental release of toxic gas Methyl Iso Cyanate (MIC).

Only in last decade, 130 significant chemical accidents reported in India, which resulted into 259 deaths and 563 number of major injuries

Following are the relevant provisions on chemical disaster management, prevailing in country:-

- | | |
|---------------------------------------|--------------------------------|
| • Explosives Act 1884 | • Petroleum Act 1934 |
| • Factories Act 1948 | • Insecticides Act 1968 |
| • Environment Protection Act 1986 | • Motor Vehicles Act 1988 |
| • Public Liability Insurance Act 1991 | • Disaster Management Act 2005 |



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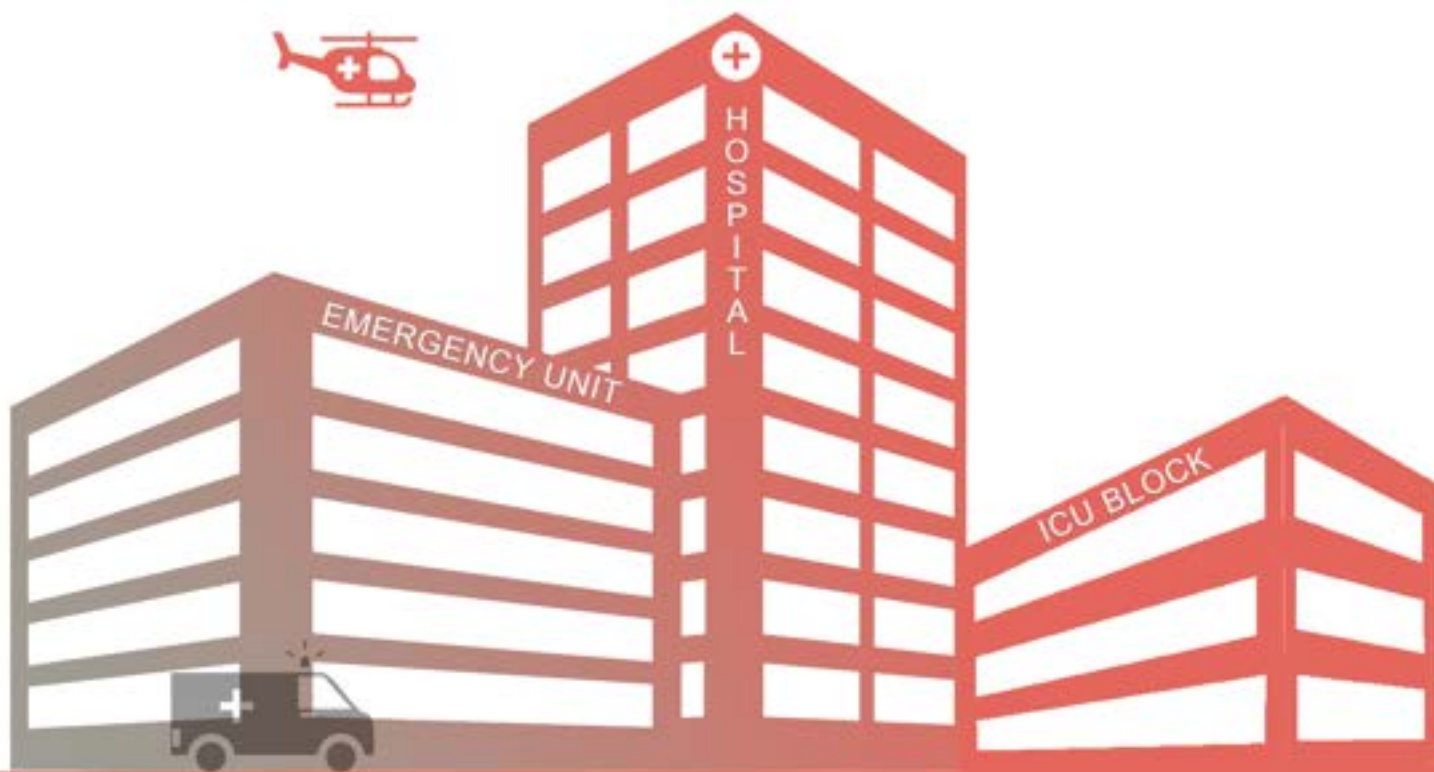
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