Chemical Incidents

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Tehran University of Medical Sciences
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Overview

- Definition
- Introduction and History
- Epidemiologic Aspects
- Public Health Consequences In Chemical Incidents
- Principles of Management
  - Planning and Preparedness
  - Response
  - Assessing the impact on public health
Chemical Incident

A chemical incident is the unexpected release of industrial material that is (potentially) hazardous either to humans, other animals or the environment.
Chemical Incident

Common synonyms include the term “accident” but this presupposes an anticipated failure of control; “incidents” include also unanticipated disasters resulting from mechanical or organizational failures, and occasionally even sabotage.
Chemical Substances

- Positive Aspects: Quality of Life
- Negative Aspects: Environmental Contaminations
- Ugly Aspects: Chemical Weapons, Narcotics, other Weapon if Mass Destructions
Introduction

- 100,000 different commercial chemicals are known
- Annual chemical production is estimated at 400 million tons
- Bulk stored and bulk transported
- Risk of large-scale release with resulting environmental and health effects
The Components of a Mobile Phone

- Box: Cardboard, Interior: Moulded polystyrene
- Bags: LDPE (Low Density Poly(ethene))
- CD-Rom and Sleeve: Polycarbonate, acrylic, paper, LDPE, Metal
- Manual: Paper
- Data Cable: PVC coated copper wire, metal connectors, PVC coated wire tie
- Housing: acrylonitrile-butadiene-styrene polycarbonate
- Charger: acrylonitrile-butadiene-styrene polycarbonate housing, PVC coated copper wire, metal connectors, ceramics
- Keys: Polypropylene
- Circuit Board: Fibreglass/epoxy composite, copper, metals, ceramics
Introduction

- 7,744 acute HazMat emergency events were reported in 13 U.S. states in 2004
- 1,978 chemical incidents in the years 2006 and 2007 in England
Introduction

- WHO: 3 mil. Admissions and 220000 Mortality Annually out of Chemical Incidents in the World
History of Chemical Weapons

- Since at Least 1000 BC (Natural Materials)
- 670 AD. Naphtha, Sulfur, Saltpeter and Pitch: Inextinguishable for Ships
- 18th Century: Chlorine & Cyanide
- WW I (25% casualties): Chlorine-Phosgene- Sulfur Mustard
History of Chemical Weapons

- World War II: “Pesticides” especially “Organophosphates” as “Nerve Agent”

- “Phenoxy” for eradicate Japanese Rice Products

The most extreme violation was by Iraq which used mustard and nerve gas against its own people, notably when it killed about 5,000 Kurds in Halabja, in March of 1988.
Chemical Weapons Convention 2007

http://mapsof.net/map/chemical-weapons-convention-2007
Chemical Weapons

Widespread Use: Geneva Protocol of 1925 (banned the use of chemical weapons)

Examples of Chemical Events
<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Description of incident</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Baton Rouge, USA</td>
<td>Release of chlorine gas from a facility</td>
<td>• No human deaths</td>
</tr>
<tr>
<td>2004</td>
<td>Neyshabur, Iran</td>
<td>Train explosion due to mixing of incompatible chemicals</td>
<td>• Hundreds of deaths and casualties among emergency responders and onlookers</td>
</tr>
<tr>
<td>2005</td>
<td>Songhua River, China</td>
<td>Plant explosion releasing 100 tonnes of pollutants in the Songhua River</td>
<td>• Five deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Millions of people without water for several days</td>
</tr>
<tr>
<td>2005</td>
<td>Bohol, The Philippines</td>
<td>Inadvertent use of an insecticide in the preparation of sweets</td>
<td>• 29 deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 104 hospitalizations</td>
</tr>
<tr>
<td>2005</td>
<td>Hemel Hempstead, England</td>
<td>Three explosions in an oil storage facility (Buncefield depot)</td>
<td>• 43 reported injuries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 2000 persons evacuated</td>
</tr>
<tr>
<td>2006</td>
<td>Abidjan, Côte d'Ivoire</td>
<td>Dumping of toxic waste in the city of Abidjan</td>
<td>• 10 deaths, thousands made ill</td>
</tr>
<tr>
<td>2006</td>
<td>Panama</td>
<td>Diethylene glycol in a cough syrup</td>
<td>• At least 100 deaths</td>
</tr>
<tr>
<td>2007</td>
<td>Angola</td>
<td>Sodium bromide confused with table salt</td>
<td>• At least 460 people ill, most of them children</td>
</tr>
<tr>
<td>2008</td>
<td>Senegal</td>
<td>Lead from informal battery recycling</td>
<td>• People exposed with many children showing symptoms of lead intoxication</td>
</tr>
<tr>
<td>Year</td>
<td>Location</td>
<td>Description of incident</td>
<td>Consequences</td>
</tr>
<tr>
<td>------</td>
<td>-------------------</td>
<td>--------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>1976</td>
<td>Seveso, Italy</td>
<td>Airborne release of dioxin from an industrial plant</td>
<td>• No immediate human deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 3300 animal deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 80,000 animals slaughtered</td>
</tr>
<tr>
<td>1984</td>
<td>Bhopal, India</td>
<td>Methyl isocyanate (MIC) leak from a tank</td>
<td>• 3800 immediate deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 15,000 to 20,000 premature deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 500,000 exposed to the gas</td>
</tr>
<tr>
<td>1984</td>
<td>Mexico City, Mexico</td>
<td>Explosion of liquefied petroleum gas (LPG) terminal</td>
<td>• 500 deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 6400 injuries</td>
</tr>
<tr>
<td>1995</td>
<td>Tokyo, Japan</td>
<td>Deliberate release of a warfare agent</td>
<td>• 12 deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 54 critical casualties</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Thousands of people affected</td>
</tr>
<tr>
<td>2000</td>
<td>Enschede, The Netherlands</td>
<td>Explosion of a fireworks factory</td>
<td>• 20 deaths, 562 casualties</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Hundreds of houses destroyed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 2000 people evacuated</td>
</tr>
<tr>
<td>2001</td>
<td>Toulouse, France</td>
<td>Explosion of 300–400 tonnes of ammonium nitrate in a fertilizer facility</td>
<td>• 30 deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 2500 casualties</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 500 homes uninhabitable</td>
</tr>
<tr>
<td>2002</td>
<td>Galicia, Spain</td>
<td>Shipwreck of the Prestige, causing the release of 77,000 tonnes of fuel</td>
<td>• Estimated clean-up costs of US$ 2.8 billion</td>
</tr>
<tr>
<td>2002</td>
<td>Jabalpur, India</td>
<td>Mass poisoning due to the use of pesticide containers as kitchen utensils</td>
<td>• Three deaths</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• At least 10 hospitalizations</td>
</tr>
</tbody>
</table>
Arsenic Use in 1946 at Stalag

- In Revenge of killing Jews in WW II
- Water and Bread Poisoning
- 1500 Injured
- 207 Hospitalized
- 700-800 Dead or Paralyzed
- Not enough document
Nerve Agent Use in Japan

- 1994: 201 km Northwest of Tokyo
- Sarin: Organophosphate Poison
- 7 Deaths, Nearly 600 Victims.
- 9 Medical staff had symptoms
Nerve Agent Use in Japan

- March 1995: Tokyo subway sarin attack
- 12 Dead, 3,938 Injured, 1100 Hospital.
- 135 EMT 110 Hospital Staff Developed Clinical Evidence
Bhopal disaster

- 3rd Dec. 1984
- Methyl Isocyananides
- 200’000- 500’000 Affected
- 3800 (3000-15000) Dead: 2-3 %

Death rate


http://visionmundial.org.sv/conoce-al-director/publicaciones-del-director/?aid=90&sa=0.
Factors Contributing to the 1984 Bhopal Disaster

- Multinational industrial producer of chemicals operates in a developing nation and does not adhere to accepted international safety standards
- Financial pressures supersede industrial safety regulations (violation of industrial zoning in the inner city, violation of limits for maximal production)
- No enforcement of international safety operational standards
- Lack of risk reduction in plant location
- Poor public health infrastructure in the vicinity of a major industrial operation
- Poor public utility infrastructure such as drinking water, sewer, electricity, and telephone
- Absence of an emergency response system for industrial accidents
- Lack of infrastructure and technical expertise to manage an industrial incident
Ammonia Release in 2002 – Minot, North Dakota

- Derailment
- Anhydrous Ammonia
- Damage to Local Power Lines
- EMS: 2,800 calls
- 370 Injured, 11 Hosp.
History In Iran

- Arak, Shazand Chemical/Explosion
- Jun 2008
- 21 Dead and 55 Injured
Zarghan Incident, Jun 2011

Photography: Fars EMS
Zarghan Incident, Jun 2011

Photography: Fars EMS
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The Number of Acute HazMat Events

1998: 5,785 \( \rightarrow \) 2001: 7,105

> 50% of Victims are Employees

Common Causes: Equipment Failure & Human Error

85% of Transport Event: Ground
Epidemiologic aspects of Chemical events in US

10 Most Frequently Released Chemical:
Ammonia (5%), Sulfur dioxide (5%), Sulfuric acid (2%), Hydrochloric acid (2%), Carbonmonoxide (2%), Sodiumhydroxide (2%), Nitric oxide (2%), Mercury (2%), Paint (2%) and Ethylene glycol (1%)
Top 10 most important Industrial Accident disasters for the period 1900 to 2012

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>No Killed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia, Explosion</td>
<td>7/08/1956</td>
<td>2700</td>
</tr>
<tr>
<td>India, Gas Leak</td>
<td>3/12/1984</td>
<td>2500</td>
</tr>
<tr>
<td>China P Rep, Other</td>
<td>26/04/1942</td>
<td>1549</td>
</tr>
<tr>
<td>France, Explosion</td>
<td>10/03/1906</td>
<td>1099</td>
</tr>
<tr>
<td>Nigeria, Explosion</td>
<td>17/10/1998</td>
<td>1082</td>
</tr>
<tr>
<td>Iraq, Explosion</td>
<td>17/08/1989</td>
<td>700</td>
</tr>
<tr>
<td>Soviet Union, Explosion</td>
<td>4/06/1989</td>
<td>607</td>
</tr>
<tr>
<td>Germany, Explosion</td>
<td>21/09/1921</td>
<td>600</td>
</tr>
<tr>
<td>United States, Explosion</td>
<td>16/04/1947</td>
<td>561</td>
</tr>
<tr>
<td>Brazil, Explosion</td>
<td>25/02/1984</td>
<td>508</td>
</tr>
<tr>
<td>Place</td>
<td>Year (start)</td>
<td>Agent(s) (contaminants)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>Airborne</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meuse Valley, Belgium</td>
<td>1930</td>
<td>Sulphur dioxide, sulphuric acid, soot</td>
</tr>
<tr>
<td>Flixborough, UK</td>
<td>1974</td>
<td>Cyclohexane, related combustion products</td>
</tr>
<tr>
<td>Meda (Seveso), Italy</td>
<td>1976</td>
<td>2,3,7,8-tetrachlorodibenzodioxin</td>
</tr>
<tr>
<td>Bhopal, India</td>
<td>1984</td>
<td>Methylisocyanate, related combustion products</td>
</tr>
<tr>
<td>Schweizerhalle, Swiss</td>
<td>1986</td>
<td>Agrochemicals, related combustion products</td>
</tr>
<tr>
<td>Chernobyl, USSR</td>
<td>1986</td>
<td>Radioactive isotopes</td>
</tr>
<tr>
<td>Foodborne</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morocco</td>
<td>1959</td>
<td>Cooking oil (triarylphosphate)</td>
</tr>
<tr>
<td>Minamata, Japan</td>
<td>1965</td>
<td>Sea food (methyl mercury)</td>
</tr>
<tr>
<td>Yusho, Japan</td>
<td>1968</td>
<td>Rice oil (polychlorinated biphenyls)</td>
</tr>
<tr>
<td>Spain</td>
<td>1981</td>
<td>Rape seed oil (aniline?)</td>
</tr>
<tr>
<td>Skin contamination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>1972</td>
<td>Baby powder (hexachlorophene)</td>
</tr>
<tr>
<td>Ho-Chi-Minh, Vietnam</td>
<td>1981</td>
<td>Baby powder (warfarin)</td>
</tr>
</tbody>
</table>
Industrial Accident; Miscellaneous accident; Transport Accident: west Asia: 200-2009


Disaster(s): Industrial Accident;

You have chosen to see the number of disasters that occurred by Country.
If there is no data for one variable of the set, it is not displayed.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
<th>Simple %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iran Islam Rep</td>
<td>6</td>
<td>100.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table Created on: **Jun-24-2012**. Data version: v12.07
## Frequency distribution of Chemicals used

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Number of Processes</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia (anhydrous)</td>
<td>8343</td>
<td>32.5</td>
</tr>
<tr>
<td>Chlorine</td>
<td>4682</td>
<td>18.3</td>
</tr>
<tr>
<td>Flammable Mixtures</td>
<td>2830</td>
<td>11.0</td>
</tr>
<tr>
<td>Propane</td>
<td>1707</td>
<td>6.7</td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>768</td>
<td>3.0</td>
</tr>
<tr>
<td>Ammonia (aqueous 20% or more conc.)</td>
<td>519</td>
<td>2.0</td>
</tr>
<tr>
<td>Butane</td>
<td>482</td>
<td>1.9</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>358</td>
<td>1.4</td>
</tr>
<tr>
<td>Isobutane</td>
<td>344</td>
<td>1.3</td>
</tr>
<tr>
<td>Hydrogen Fluoride</td>
<td>315</td>
<td>1.2</td>
</tr>
<tr>
<td>Pentane</td>
<td>272</td>
<td>1.1</td>
</tr>
<tr>
<td>Propylene</td>
<td>251</td>
<td>1.0</td>
</tr>
<tr>
<td>Methane</td>
<td>220</td>
<td>0.9</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>205</td>
<td>0.8</td>
</tr>
<tr>
<td>Isopentane</td>
<td>201</td>
<td>0.8</td>
</tr>
<tr>
<td>All Others</td>
<td>4139</td>
<td>16.1</td>
</tr>
</tbody>
</table>

Most common hazardous materials at fatal hazmat incidents

<table>
<thead>
<tr>
<th>Hazardous Material</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides</td>
<td>24.4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>17.3</td>
</tr>
<tr>
<td>Corrosives</td>
<td>16.7</td>
</tr>
<tr>
<td>Petroleum products</td>
<td>13.5</td>
</tr>
<tr>
<td>Airborne toxicants</td>
<td>7.7</td>
</tr>
</tbody>
</table>
Site Distribution of Chemical Accidents

- Fixed facility
  - Industrial
  - Agricultural
  - Residential

- Transportation-related
  - Highway
  - Railway
  - Airport
  - Port
What HSEES system information has shown

- Approximately 9,000 hazardous substances releases occur annually in the 15 states reporting.
- Transportation-associated releases account for 25%–30% of reported events.
- Most releases occur on weekdays between 6 AM and 6 PM.
What HSEES system information has shown

- Releases tend to increase in spring and summer.
- Equipment failure and human error cause most releases at facilities.
- More than 90% of events involve the release or threatened release of only one hazardous substance.
What HSEES system information has shown

- Releases of hazardous substances most often injure employees, followed by the general public

- Respiratory irritation and eye irritation are the most commonly reported symptom or injury.
Hazardous Substances Emergency Events Surveillance (HSEES)

- 1,691 hazmat incidents:
  - 7,756 patients

- 61 fatal hazmat incidents:
  - 83 fatalities
    - 63 employees (76%)
    - 16 members of the general public (19%)
    - 4 rescue personnel responding to the hazmat incident (5%)

- 1% case fatality rate
  - 83 of 7,756 hazmat patients died

Amit Gupta
Assistant Professor of Surgery
JPN Apex Trauma Center
All India Institute of Medical Sciences
Fresno County HAZMAT Incident Study

Patient Involvement

- 107 (100%) total incidents
- 97 (91%) incidents without patients
- 10 (9%) incidents with patients

Patient Disposition

- 68 (100%) total patients
- 42 (62%) patients released at scene with on-line medical control
- 26 (38%) patients transported to emergency departments
  - 4 patients admitted
- No fatalities

www.hrdp-idrm.in/live/hrdpmp/hrdpmaster/.../ChemicalTalk
Avazi and colleagues In Shiraz:

Out of 1543 Admission of Poisoned 12/3 percent : Pesticides
Key Epidemiological Points

■ More than one material possible per hazmat incident, however - Most hazmat incidents involve only one material

■ Most commonly encountered material is directly related to local economy

■ Most hazmat incidents do not involve patients and have low overall fatality

■ Most hazmat victims not admitted to hospitals

■ Hazmat training must emphasize
  □ Personnel protection
  □ Proper patient decon
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Mechanism of Health Effects of Chemical incidents

- Explosion
- Fire
- Chemicals (Spills and Leaks)
- Structural Collapse
Some Notes about CHEMICAL EVENTS

- Degree and Speed of Symptoms Depends on Amount and Speed of Chemical
- Most Clinical Effect of Chemicals: Study on Young & Healthy Men
- Investigations has Problem: New Chemicals, Multiple Chemical, Non Human Studies
Some Notes about CHEMICAL EVENTS

- Detailed Studies is Needed
- Public Anxiety May Doubt the Data Released by Media and Routine Reporting
- Long-Term Clinical Effects Should be Considered
Health Effects of Chemical Incidents

- Carcinogen
- Irritant
- Corrosive
- Sensitizer
- Reproductive toxin
- Target organ-specific agent
 مشخصات فیزیکی یک ماده شیمیایی

قابل اشتعال: به آسانی آتش می‌گیرد و سریعاً می‌سوزد و به صورت گاز مایع - جامد وجود دارد. مايعات قابل اشتعال معمولاً نقطه اشعال زیر Flammable

قابل احتراق = مشابه موادقابل اشتعال هستند اما به آسانی محترق نمی‌شوند وعمولاً نقطه اشعالی بین 72/37/33/93 درجه دارند. مانند کروزن.

قابل انفجار: منفجر شوند وموادی که گاز آزاد کرده و سبب انفجار می‌شود Explosive

اکسید کننده= سوختن مواد دیگر را طی واکنش یا تغییر شیمیایی تسهیل می‌کند. مانند نیترات آلومینوم Oxidizer
مشخصات فیزیکی یک ماده شیمیایی

پراکسیدهای آلی: دارای اکسیژن مزدوج می باشند و فعال و ناپایدار. مانند Organic peroxide می توان یک نکه ساختن ناپایدار= هنگام مواجهه با شوک، حرارت، مانند فشار ممکن است به راحتی با مواد دیگر واکنش دهد یا واکنش خود به خودی داشته باشند و درهنگام حمل و نقل و نگهداری تماپایل به تجزیه دارند. مانند پراکسید ها. واکنش پذیر با آب: با آب واکنش داده ایجاد گاز قابل اشتعال یا یک خطر بهداشتی می کنند. مانند سدیم Unstable вод reaction اشتهای: قابل اشتعال و خود به خود با شعله ای در دمای زیر ۴۳ درجه سلسیوس می سوزند. مانند Fسفر سفید pyrophoric
Most Common Fatal Injuries

- Most common reported *fatal* injuries
  - Trauma (65%)
  - Thermal burns (16%)
  - Respiratory irritation with airway obstruction &/or respiratory failure (10%)
  - Chemical burns (6%)
  - Other causes (3%)

www/hrdp-idrm.in/live/hrdpmp/hrdpmaster/.../ChemicalTalk
Fatal Injuries

- 3 to 5% of Exposed: Lethal Sequelae
- Primarily Respiratory in Nature
What is wrong with the patient

- Physical Trauma
- Exposure to Chemical HAZMAT
  - Inhalation
    - Most common
  - Skin & mucous membranes
    - Common
  - Ingestion & Injection
    - Unlikely
- Toxicity
  - Local
  - Systemic
Chemical Weapons

The Four Basic Classes of Chemical Agents

- Nerve
- Blistering
- Blood
- Respiratory
Public-Health Effects of Chemicals

- Stress and Anxiety
- Deaths and Illness
- Societal and Economic Costs
- Environmental Effects (Insidious and Cumulative)
- Animals and Plants Effects
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Operational Planning and Preparedness

- Multidisciplinary public-health working arrangements
- Vulnerability assessment
- Local incident surveillance and environmental monitoring
- Baseline health assessment
- Health impact assessment
- Baseline environmental assessment
# Multidisciplinary public-health working arrangements

## Table 12.1 Organizations and groups involved in planning for, and managing, chemical incidents

<table>
<thead>
<tr>
<th>Public-health/environmental-health departments and institutes</th>
<th>Public and community groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poisons centres</td>
<td>Emergency services/civil defense</td>
</tr>
<tr>
<td>Toxicology laboratories</td>
<td>— fire</td>
</tr>
<tr>
<td>Local hospitals</td>
<td>— police</td>
</tr>
<tr>
<td>Specialist hospitals</td>
<td>— ambulance</td>
</tr>
<tr>
<td>Occupational health services</td>
<td>— transport</td>
</tr>
<tr>
<td>Food safety organizations</td>
<td>— emergency medical responders</td>
</tr>
<tr>
<td>Local government</td>
<td>Military</td>
</tr>
<tr>
<td>Central government</td>
<td>Specialist environment agencies</td>
</tr>
<tr>
<td>Major local chemical industries</td>
<td>— rivers</td>
</tr>
<tr>
<td>Environmental groups, pressure groups and watchdogs</td>
<td>— ocean/sea</td>
</tr>
<tr>
<td>Nongovernmental organizations /Red Cross/Red Crescent</td>
<td>— wildlife</td>
</tr>
<tr>
<td></td>
<td>— transport</td>
</tr>
<tr>
<td></td>
<td>— agricultural</td>
</tr>
<tr>
<td></td>
<td>— air quality</td>
</tr>
<tr>
<td></td>
<td>Pollution control agencies</td>
</tr>
<tr>
<td></td>
<td>— factories inspectorates</td>
</tr>
<tr>
<td></td>
<td>Weather services</td>
</tr>
</tbody>
</table>
Vulnerability assessment

- Identification of hazardous chemical sites, pipelines and transport routes
- Identification of possible incident scenarios and their exposure pathways
- Identification of vulnerable populations, facilities and environments
- Estimation of the health impact of potential chemical incidents and the requirements for health-care facilities.
Operational Planning and Preparedness

- Liaison with the local community
- Public-health plans for chemical incidents
- Databases
- Reducing the probability of incidents
- Reducing the health risks of incidents
- Establishing routine procedures
- Conducting exercises and training
Standards of Chemicals

- Chemical Abstracts Service (CAS): US
- four-digit United Nations Substance Identification Number (UN SIN or UN Number)
- Labeling (Various Systems)
- Material Safety Data Sheets (MSDSs)
- International Chemical Safety Cards (ICSC)
- TREMCARDS (transport emergency cards)
سازمان‌های های استاندارد

- OSHA (اداره ایمنی و بهداشت شغلی)
- NIOSH (انسیتو ملی ایمنی و بهداشت آمریکا)
- ACGIH (کنفرانس دولتی بهداشت صنعتی آمریکا)
- EPA (آژانس حفاظت محیط زیست)

www.OSHA.gov
www.cdc.gov/niosh
www.acgih.org
www.epa.gov

- Occupational Safety and Health Administration
- National Institute for Occupational Safety and Health
- American Conference of Governmental Industrial Hygienists
- Environmental Protection Agency
Standards Hazard Labels
Standards Hazard Labels

Labels (example)

METHYL ALCOHOL
CAS:67-56-1
DOT-ID:NA 1230

Protective Equipment:
OSHA Table Z-1-A air contaminant. Approved canister mask for high vapor concentrations; safety goggles; rubber gloves.

MaxiSoft, Inc.

HEALTH HAZARD
4 - Deadly
3 - Extreme Danger
2 - Hazardous
1 - Slightly Hazardous
0 - Normal Material

FIRE HAZARD
4 - Flammable
3 - Very Flammable
2 - Easily Ignitable
1 - Combustible
0 - Will not Burn

REACTIVITY
4 - May Detonate
3 - Shock and Heat May Detonate
2 - Violent Chemical Change
1 - Unstable If Heated
0 - Stable

SPECIFIC HAZARD
OXY - Oxidizer
ACID - Acid
ALK - Alkali
COR - Corrosive
Use NO WATER

RADIATION HAZARD

PPE

PERSONAL PROTECTIVE EQUIPMENT RECOMMENDATIONS
Hazard Labels and Classes

- Explosives
- Gases
- Flammable Liquids
- Flammable Solids
- Oxidizing Substances
- Toxic and Infectious Substances
- Radioactive Material
- Corrosives
- And Miscellaneous Dangerous Goods
Graphic Hazard Signs

- Flammable
- Explosive
- Oxidizer
- Corrosive
- Toxic
- Carcinogenic
- Water Reactive
- Radioactive
- Biohazard
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM

HAZARD INDEX

4 = SEVERE HAZARD
3 = SERIOUS HAZARD
2 = MODERATE HAZARD
1 = SLIGHT HAZARD
0 = MINIMAL HAZARD

An asterisk (*) or other designation corresponds to additional information on a data sheet or separate chronic effects notification.

PERSONAL PROTECTION INDEX

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X

Consult your supervisor or S.O.P. for "SPECIAL" handling directions.
Personnel Protection Equipment

Photo credit: MJ Moradian
Personnel Protection Equipment
Hospital HazMat Response Notes

- Hazards and vulnerabilities identified in a HVA
- Estimated time before arrival based on location of hazard
- Casualty care areas
- Decontamination procedures and protocols
Hospital HazMat Response Notes

- Secondary contamination and containment of contaminated equipment and run-off water
- Safety: personal protection equipment
- Communications at decontamination area
- Heating, ventilating, and air conditioning and in-place protection
Hospital HazMat Response Notes

- Medical management – antidotes
- Interfacility transfers – patients with special needs, burn patients
- Knowledge resources for hazardous materials
Overview

- Definition
- Introduction and History
- Epidemiologic Aspects
- Public Health Consequences In Chemical Incidents
- Principles of Management
  - Planning and Preparedness
  - Response
  - Assessing the impact on public health
General Indicators of Possible HazMat Event

- Unusual occurrence of dead or dying animals (such as dead birds)
- Unexplained casualties (multiple victims with the similar signs and symptoms such as skin, respiratory system, vision, and nervous system involvement)
General Indicators of Possible HazMat Event

- Increase in the frequency of those with the aforementioned signs and symptoms in the direction of prevailing winds
- Unusual liquid or vapor clouds (droplets, unexplained odor, or taste)
- Mass casualties without any conventional injuries
Response to Chemical Incidents

- Alerting the health-care services
- Best outcome assessment/estimation
- Information and Risk communication skills
- Advice on protection
- Sheltering or evacuation/removal
- Other restrictions to protect health
- Organizing registers and samples
Response to Chemical Incidents

- Collection of samples—biomarkers of chemicals and their effects
- Environmental monitoring
Restrictions of Oil spread on the water

Photo credit: MJ Moradian
Belarus, 2009
Restrictions of Oil spread on the water

Photo credit: MJ Moradian
Belarus, 2009
Restrictions of Oil spread on the water

Photo credit: MJ Moradian
Belarus, 2009
## Table 2  Specimen collection for biomarkers following a chemical incident

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Preservative</th>
<th>Volume*</th>
<th>Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>Lithium heparin</td>
<td>10 ml</td>
<td>Unknown, pesticides, herbicides</td>
</tr>
<tr>
<td>Blood</td>
<td>EDTA</td>
<td>5 ml</td>
<td>Unknown, solvents, metals, trace elements</td>
</tr>
<tr>
<td>Blood</td>
<td>None (for separation and retention of both serum and clotted blood)</td>
<td>10 ml</td>
<td>Unknown, rodenticides</td>
</tr>
<tr>
<td>Urine</td>
<td>None</td>
<td>50 ml</td>
<td>Unknown, metals, trace elements, pesticides, herbicides</td>
</tr>
<tr>
<td>Hair</td>
<td>None</td>
<td></td>
<td>Unknown, trace elements</td>
</tr>
</tbody>
</table>

* Halve for children.
Hazmat Incident Priorities

- Communication and coordination
- Protection of emergency responders
- Prevention of secondary contamination
  - Decon
- Decreasing morbidity & mortality
  - Medical management
Protection of Responders: Hazmat Scene Control Zones

- **Hot Zone**
  - Primary contamination

- **Warm Zone**
  - Decon of victims, rescue personnel, & equipment

- **Cold Zone**
  - Incident command center
  - Definitive Triage and immediate treatment of decontaminated patients
South Fars Chemical Exercise 2009

Photo credit: Fars EMS
Medical Management of Hazmat Victims

- Decon
- Primary Survey & Resuscitation
- Hazmat Patient Assessment
  - AMPLE History
  - Secondary Survey
- Poisoning Treatment Paradigm™
Triage In Chemical Incidents

Figure 31.3. Trauma and chemical triage. *Give antidote if available and logistically feasible. Decontaminate all patients prior to transport.
Skin Decontamination (Decon)

- 2 goals
  - Prevent secondary contamination
  - Alter absorption

- Is skin decon necessary?
  - Usually not for gases & vapors
    - Unless irritant gas causes signs or symptoms
  - Necessary for adherent solids or liquids, including aerosols
    - If water-soluble, then use water
    - If not, then use water & mild liquid detergent

- Dilution is the solution to pollution
- Performed in warm zone
Skin Decon

2-step process

- **1st** - Remove all clothing, jewelry, shoes, & adherent material
  - Bag, tag, & leave possessions at scene
  - Brush away adherent solids
  - Blot away adherent liquids

- **2nd** – Meticulously wash with large quantities of water
  - Use mild liquid detergent if adherent solids or liquids are not water-soluble or are unknown materials
  - Pay attention to exposed skin in skin folds
Man dropped bucket of silver paint that splattered onto areas of body commonly ignored or forgotten during decon.

Photo credit: Mike Vance, MD
Can of mace went off in pants pocket & pants not removed in timely manner.
Eye Decon

- Irrigate exposed, symptomatic eyes immediately & continuously
  - Use water or saline
    - Water is best
      - Readily available in large quantity
      - Efficient
  - Check for & remove contact lenses
Severe corneal chemical burn
- Opaque cornea
- Blind eye
- Requires cadaver corneal transplant

Photo credit: Mike Vance, MD
Primary Survey & Resuscitation: The Basics

- Performed only after adequate decon in warm zone / ED Decon area
- Only two procedures performed before decon
  - Open airway
  - Spine precautions
- Use common sense
- Safety comes first

www.hrdp-idrm.in/live/hrdpmp/hrdpmaster/.../ChemicalTalk
Recognize Toxic Syndromes

- 5 fundamental hazmat toxidromes
  - Irritant gas
  - Asphyxiant
  - Cholinergic
  - Corrosive
  - Hydrocarbon & halogenated hydrocarbon

Toxic + syndrome = Toxidrome (Page 522: Table 31.6)
<table>
<thead>
<tr>
<th>Antidote</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Hydrofluoric acid or fluoride</td>
</tr>
<tr>
<td>Hydroxocobalamin</td>
<td>Cyanides</td>
</tr>
<tr>
<td>Atropine</td>
<td>Organophosphates, carbamates, nerve agents</td>
</tr>
<tr>
<td>Amyl nitrite</td>
<td>Cyanides, nitriles, sulfides</td>
</tr>
<tr>
<td>Methylene blue</td>
<td>Methemoglobin-forming compounds</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Simple asphyxiants, systemic asphyxiants, methemoglobin-forming compounds, carbon monoxide, cyanides, azides and hydrazoic acid, hydrogen sulfide and sulfides</td>
</tr>
<tr>
<td>Oximes</td>
<td>Organophosphates, nerve agents</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>Hydrazones</td>
</tr>
</tbody>
</table>
Overview

- Definition
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  - Response
  - Assessing the impact on public health
Assessing the Impact on Public Health

Aims:

- To offer advice about exposure and protection
- To offer advice about treatment
- To contribute to the public health toxicological information base
Assessing the Impact on Public Health

Stages:

1. Preparedness
2. Rapid health-risk assessment
3. Exposure assessment
4. Assessment of acute health effects
5. Assessment of longer-term health effects
6. Epidemiological studies
# Epidemiological Study for Chemical Incidents

## Table 12.2 Different types of epidemiological study

<table>
<thead>
<tr>
<th>Analytical studies</th>
<th>Descriptive studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel studies</td>
<td>Ecological studies</td>
</tr>
<tr>
<td>Cohort studies</td>
<td>Cluster investigations</td>
</tr>
<tr>
<td>Case-control studies</td>
<td>Disease and symptom prevalence studies</td>
</tr>
<tr>
<td></td>
<td>Cross-sectional studies</td>
</tr>
</tbody>
</table>
Principles For Epidemiological Assessment

- Communication and coordination
- Populations at risk
- Case definitions
- Exposure assessment
- Cross sectional survey
- Case referent study
- Cohort study
What Can We Do for Chemical Incidents?

- Before the incident:
  - Prepare for that
  - Reduce the risk
  - Map the risky sites
  - Stabilize EWS
  - Educate all groups
  - Develop plans
  - Stock Equipments

- After that:
  - EWS
  - Locate the site
  - Detect the substances
  - Limit the zones
  - Dispatch responders
  - Decontaminate
  - Treat the injured
  - Do surveys
Overview

- Definition
- Introduction and History
- Epidemiologic aspects
- Public Health Consequences In Chemical Incidents
- Principles of Management
  - Planning and Preparedness
  - Response
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Main Reference
