

# Mapping Toxic Disasters around the Globe: An Indian Society of Toxicology Initiative for Legal Regulation on Environmental Toxicity

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## Abstract:

Mapping Toxic Disasters, based on the past incidences becomes relevant. So, the Toxic Map is prepared by the Indian Society of Toxicology to call out the emergency medical services to prepare for managing the future toxic disasters, based on the common toxins in that region, easily available to the vulnerable population. The goal of the initiative is to prioritize toxic xenobiotic substances for further in-depth toxicological evaluation as well as identify their pattern of availability in the environment, in their region of production, consumption or improper disposal, and further prevention of such as toxin-associated morbidity & mortality in community, leading to mass casualties, since the time immemorial.

**Keywords:** (Toxicity, Map, Atlas, Global, disaster, environment, Health, safety, prevention, preparation, Hazardous)

## Introduction

Environmentally Toxic Exposures: A to Z in environmental toxicity caused by CBRNE.

CBRNE stands for:

- *C-Chemicals*- HOOCH - Methanol, ethylene glycol;; OPC (Organophosphates)- Tabun, Sarin, Soman; Methylene Isocyanate (MIC)- Bhopal gas; Cyanide/ CO/ H<sub>2</sub>S gas
- *B-Biological* - Anthrax, Smallpox

- *R-Radiological* - Radioactive heavy metals- Polonium
- *N-Nuclear Disasters*- Hiroshima Nagasaki in Japan
- *E-Explosives*- Iran Iraq War

Search for Toxic look- alike, Toxic sound- alike, Toxic taste- alike, Toxic smell- alike on & around the victim, after checking scene safety as per WHO protocol: Dr.ABCDE (easy recall as name of some unknown doctor)

This follows the general principles of life support given below:

- Dr-ABCDE
- D - DANGER - scene safety- Radiation/ Hazardous chemical/ Cyanide/CO/H<sub>2</sub>S gas
- R - RESPONSE- call for help
- A - AIRWAY secured & maintains patency/ Antidote
- B - BREATHING support
- C - CIRCULATION maintain access
- D - DISABILITY/ Decontamination- Whole body
- E - EXPOSE THE PATIENT completely- to find poisonous bites/stings
- F- Foley's catheterization for rapid excretion of toxic metabolites
- G-Gastric lavage for decontamination
- I- Isolation of patient & I-Intermittent rotation of Health Care provider to prevent further spread of toxicity to others (occupational hazards)

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## Mapping Atlas of Toxic Disasters around the Globe Indian Society of Toxicology

North West (Europe)	North (Ukraine-Russia- Siberia)	North East (China, North Korea)
<ul style="list-style-type: none"> <li>Jewish German Holocaust- Cyanide Gas<sup>1</sup></li> <li>Toxic chemical spill (Switzerland) Rhine Red, Fish Dead (organophosphate insecticides, mercury compounds &amp; Organochlorines)<sup>3</sup></li> <li>Notre Dame Holy waterpoisoning in Paris</li> <li>Dioxin- Seveso industrial disaster-Italy<sup>17</sup></li> <li>Huelva mines- Metal fume toxicity in Riotinto<sup>33</sup></li> </ul>	<ul style="list-style-type: none"> <li>Chernobyl Nuclear Disaster -Ukraine radioactive metal toxicity<sup>8</sup></li> <li>Rum Whiskey intoxication</li> <li>Rasputin Execution failed - Cyanide laced Rum-Cake<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Opium-silk route (Golden Triangle)<sup>23</sup></li> <li>Baotou toxic lake: man-made lake of toxic waste<sup>18</sup></li> </ul>
West (North America - USA, Mexico, Canada)	Central (Middle East,Africa-Arabia-UAE)	East (South Korea Japan)
<ul style="list-style-type: none"> <li>Battery lead contamination-Industrial Lead toxicity in Los Angeles, California<sup>4</sup></li> <li>Greenpoint Oil Spill - Brooklyn, New York<sup>5</sup></li> <li>Toxic Potato Salad (Ohio)- Large outbreak of botulism associated with a church potluck<sup>6</sup></li> <li>Bitter Coffee at Church Breakfast- Cyanide Tragedy<sup>7</sup></li> <li>United States of Toxins- Utah &amp; Nevada- metal mining- metal fume toxicity<sup>20</sup></li> <li>Iatrogenic Opioid Epidemic<sup>24</sup></li> </ul>	<ul style="list-style-type: none"> <li>Lily of the Valley<sup>28</sup></li> <li>Mad-Honey, bee and wasp stings</li> <li>Cantharides</li> <li>Golden Crescent- Opium (Afghanistan-Iran-Pakistan)<sup>25</sup></li> <li>Carbon monoxide - Gas Heaters<sup>27</sup></li> <li>Apricot- Cyanide<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Red-tide + Harmful algal bloom in sea coast in summers<sup>29</sup></li> <li>Seafood poisoning - Fugu, Ciguatera</li> <li>Sarin (OPC) Tokyo Subway - Bioterrorism (641 victims)<sup>15</sup></li> <li>Fukushima Daiichi nuclear disaster<sup>16</sup></li> <li>Cadmium toxicity - Itai-itai disease- "it hurts-it hurts disease" Jinzu river basin-Toyama Prefecture, Japan<sup>35</sup></li> <li>Methyl mercury- Minamata disease<sup>18,19</sup></li> <li>Hiroshima Nagasaki Nuclear Attack &amp; resulting toxicity in Japan<sup>37</sup></li> </ul>
South West (South America, Brazil, Peru, West Indies)	South (Australia, South Africa)	South East (Asia -India- Malaysia, Cambodia, Thailand, srilanka)
<ul style="list-style-type: none"> <li>Black widow Spider</li> <li>Black scorpion</li> <li>People's temple massacre -Cyanide laced drinks<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Rattle Snake and Coral Snake<sup>32</sup></li> <li>Ivory Coast toxic waste dumped of toxic oil sludge</li> <li>Esperance's lead poisoning disaster<sup>21</sup></li> </ul>	<ul style="list-style-type: none"> <li>Opium (Golden triangle) India-China- Malaysia- Thailand<sup>22</sup></li> <li>East India: toxic runoff of Arsenic, Pesticides<sup>26</sup></li> <li>India, Srilanka- Cobra, Viper, Krait<sup>1</sup></li> <li>Western Ghats- Red scorpion<sup>2</sup></li> <li>HOOCH Tragedy- Methanol Country Liquor- Malaysia, India</li> <li>Methyl IsoCyanate (MIC) Bhopal Gas Tragedy- World's Worst Industrial Disaster</li> <li>South India: Cyanide Tragedy by Goldsmith's powder (KCN)- Cyanide Mallika<sup>9,10</sup>, Cyanide Mohan<sup>11</sup>, Cyanide Jolly-killer of kin- Soup<sup>12</sup>.</li> <li>Cyanide Rash- Cassava tubers, Tapioca</li> <li>Karnataka-Pesticide casualty - Holy Prasad<sup>13</sup></li> <li>Carbon monoxide epidemic in winters-Sigdi, Kangri Gas Geysers</li> </ul>

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\*Rx- Decontamination\* & Antidotes in HAZMAT protocol:\* ABCDEFGHIJKL

- A-ALARA (As Low As Reasonably Achievable) principle
- A-Antidotes (Atropine/ PAM/ NAC/ KI) / Activated charcoal / Antibiotic prophylaxis for immunocompromised
- B- Blocking absorption (Radioiodine absorption blocked with potassium iodide),
- B-Bronchoalveolar lavage for removing inhaled HAZMAT
- C- Chelating agents for radioactive metals (Prussian Blue chelates Caesium & Thallium; DTPA chelates Plutonium, Americium, Curium)
- C-Counters of counting toxic radiation dose
- C-Cytokines / CSF (Colony Stimulating factors) for managing low Blood counts

- D- Decontamination of clothes, hair / Detoxify / DMPA / Dosimeters
  - E- Emesis timing prognosis/ Exposure/ Elimination by Dialysis / EDTA
  - F-Foley's catheter- 24 hr urine collect
  - G- Gastric lavage within 1 hour
  - I-Isolation of patient, his waste, his clothes/ I-Isotopic Dilution
  - J-Judicious investigations of all body fluids
  - K- KI for Radio iodine
  - L- Lymphocyte count depletion\
- PPE (\*Personal-Protective-Equipment\*) for HAZMAT Team handling victims:
- HAZMAT- stands for HAZardousMATERial: radiotoxic solids/liquids/Gas
- A-Aprons of Lead

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



**Fig. 1:** Hazardous material disposition in coloured bins (Cited from our book on Critical care nursing in Emergency toxicology)

mucous membrane protection is needed.

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

## Discussion

Mapping Toxic exposures is utilised by crime investigation agencies like CIA (Central Investigating Agency) of America, and thus the terms has come: Golden crescent & golden triangle of Opium trafficking.

Crescent moon symbolises Islamic Republic-Afghanistan, Pakistan Iran, have crescent moon in their flag, calendar is based on the moon waxing & waning, and opium is sold & supplied in exchange to gold at high price illegally from these countries, so its nicknamed as golden crescent.

**Toxic Runoff during Floods:** The inundation of an area with water can cause chemical release in other ways. In rural areas, runoff from flooded areas can carry with it eroded soil containing fertilizers, herbicides and insecticides. Runoff from motorways, roads and bridges may contain heavy metals, petroleum hydrocarbons and polycyclic aromatic hydrocarbons. Runoff from inundated waste sites may contain a variety of toxic chemicals, depending on what was stored on the site. Arsenic Floods in Rice Harvest in East India. Some crops, such as rice, absorb arsenic easily, leading to contamination in the food chain. An estimated 1,360 tonnes of arsenic are pumped up by the tubewells and added yearly to the fertile soils here. For the last two decades the world has been trying to explain how arsenic leaches into groundwater in the Ganga-Meghna-Brahmaputra floodplain. The latest research says floodwaters can remove arsenic.

**Carbon monoxide poisoning during floods and winters:** Carbon monoxide poisoning resulting from the incorrect use of fuel burning generators for electricity, barbeques, braziers or buckets of coal or charcoal for heating and cooking, or petrol-driven pumps and dehumidifiers to dry out flooded rooms. CO poisoning must form part of syndromic (Toxidrome) and event based surveillance systems for flooding and should be included in measures of the health impact of flooding.



Fig. 2: Toxic Calendar by Indian Society of Toxicology

On August 20, 2006, toxic waste was illegally exported from Europe by multinational trading company and left in Akouodo, a dump site in the middle of a poor residential area of Abidjan, and in 18 other sites in the city. Tens of thousands of people suffered severe health effects and 15 to 17 people died. The waste was produced from unrefined gasoline by a process called caustic washing, a process banned by most countries. Ivorians staged protests and demonstrations in the city following the dumping.<sup>32</sup>

In Japan the most heavily cadmium (Cd)-polluted region is the Jinzu river basin, where Itai-itai disease is endemic and the Kakehashi river basin is the second most polluted region.. The village average Cd concentrations in rice were distributed in the range between 0.02 microg/g and 1.06 microg/g in the Jinzu river basin and 0.11 microg g and 0.67 microg g in the Kakehashi river basin. Severe renal damage has occurred widely in the Jinzu river basin. Dose-response relationships between Cd exposure and health effects were clearly demonstrated in both regions.<sup>35</sup>

Hazardous-Material\* disposal- HAZMAT Protocol of Colour Coding of \*Bio-Medical-Waste\*(BMW) disposal bins inside Hospital.Easy recall colour of BMW disposal bins inside Hospital: Coloured Bio Medical Waste (BMW) bag disposal as per indian Bio-Medical Waste Management Rules, 2016.<sup>36</sup>

- R-\*Red-Bin\*- \*Recyclable\* waste(R-R)- \*Red\* blood soaked (used) \*Rubber\* gloves, Rubber & Plastic tubes & IV sets.
- Y-\*Yellow-Bin\*- pus(Yellow) soaked Cotton Gauze pieces & dressing, Microbiology Waste (infected pus(Yellow) producing Bacteria), Human anatomical waste (tissues, organs, fetal parts)- infected (pus filled -Yellow), Animal waste, Empty Blood bags, soiled (Yellow) linen & Contaminated Bedsheets, discarded cytotoxic drugs for Burning infective waste in Yellow fire during incineration.
- W- \*White Puncture-Proof-Bin\* - Whole (unbroken) metallic (White) needles, blades & sharp waste.
- \*Brown-Cardboard-Box\* with \*Blue-Marking\*- Unbroken Broken glass (Nukila Glass in Neela (Blue lining Brown Box)) & Body implants(metallic).
- \*Black-Bin\*- Black & white paper(non-infectious) waste- paper wraps & medications boxes of paper, tissue paper after drying washed hands.

We must underline the fact that the toxicology experts developed their assessment, identification, intervention, investigations & management in a highly charged toxic environment, causing secondary exposure to the toxins, in which arguably several strong stakeholders from the commercial industry & politics intervene, not only in establishing new regulations but also in defining risk. The lessons learned from establishing the cohorts and the pioneering analyses by Toxic detective scientists should serve as a legacy for future generations who experience occupational, medical, or environmental radiation exposures.<sup>37</sup>

#### *Updates on Workshop Proceedings for preparation and prevention of Toxic Disasters*

Recently Our Toxic detective course by Indian Society of Toxicology (IST) was successful & houseful with 31 participants from all over India & abroad-Nepal (Students of Forensic Science, Forensic Medicine, Law students, and all interns, paramedics and Toxicology Nurses) and 20 faculties from all over India & abroad-Nepal, so our course by IST became internationally recognised & accepted for preventing mass disasters. It was interactive & informative as per feedback of participants & faculties. We completed it as per schedule of one day. This course was targeted for all the professionals, engaged in handling toxicological emergencies of any kind, and took this workshop as a learning experience, and the training on simulation as an introduction to Crime Scene Investigation & Environmental Toxicology.

We conducted pre & post Tests by using Online Google form, so everyone on the whatsapp group of Toxic detective could access by filling his name & email ID. That prevented wastage of paper and gives easier analysis.

Their Pretest & Post-test results comparison showed the positive impact of our unconventional method of teaching by using hand's on training on allowing all the participants to do analytical toxicology one by one on stage under supervision & guidance of the faculties. Hon'ble Past President of IST- Dr Prateek Rastogi Sir-(Kasturba Medical College, Mangalore), & Our Chief guest of honor- Respected Dr yatin Mehta Sir (Department of Critical Care, Medanta Gurugram), inaugurated the event by releasing the Toxic Calendar by Indian Society of Toxicology (Fig. 2).

For first time, our IST team demonstrated & taught the utilisation of pelvic binder in sexual assault victims bleeding by simulation on Barbie

dolls under supervision of Dr Richa Chaudhary, Associate Professor of Forensic Medicine & Toxicology at DrRMLIMS, Lucknow & Dr Vidusha Vijay, Department of Forensic Medicine & Toxicology, Victoria Hospital, Bengaluru. We kept the artificial decorative plants, roots, fruits & berries for learning botanical identification of toxic plants, on which Dr PriyamwadaKurveti, Associate Professor of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal educated the participants' alongwith Dr Ramesh K Maharjan, Professor of Emergency, Tribhuvan University, Nepal.

Similarly we used the animal toys of rubber to educate identification of the venomous snakes, scorpions, spiders, insects, sea-fishes causing toxicity taught by Dr Shiuli Rathore, Assistant Professor of Forensic Medicine & Toxicology, KGMC, Lucknow along with Dr RK Gorea, Professor of Forensic Medicine & Toxicology, Gian Medical College, Punjab & Parmod Goyal, Professor of Forensic Medicine & Toxicology, Adesh Institute of Medical Sciences & Research, Bathinda.

For simulating drugs of abuse, we kept the different coloured powders (salt, sugar, brown sugar, talcum powder) to get the visual identification of common drugs prepared illegally to bypass the legal regulation of NDPS and prevent being caught, as they look harmless household products.

Dr Amita Srivastava, Senior Scientist of AIIMS Poison Information Centre, Delhi&Dr Shikha Tandon, Consultant of Emergency, Fortis Hospital,delhitaught about antidotes by keeping their branded medication boxes with smiles &dingling eyes, talking to the participants (done by faculties holding in their hands the antidote box) and telling the indications, contraindications, method of administration.

20 Colour tests by World Health Organisation (WHO) to identify the common poisons were demonstrated live by Dr Arun Kr. Harith, Senior Consultant of Biochemistry, Medanta the Medicity, Gurugram alongwith Dr Pallavi Jain, Assistant consultant of Biochemistry, Medanta the Medicity, Gurugram.

Our IST team conducted role plays of toxic disasters by volunteers from emergency, biochemistry, Forensic Medicine, forensic science, law students, who volunteered for the event role plays on Hooch tragedy and antifreeze toxicity among kids-performed very well by all including Ms Richa thakur, Emergency nurse, Medanta Medicity, along with Tincy, Reena, Rajni-our

emergency nursing officers under direction of Dr ArjitDey, Senior Resident from Forensic Medicine & Toxicology, AIIMS Delhi.

On behalf of Department of Emergency & Trauma Care, Medanta Medicity, We have scheduled similar Toxic detective course 2020- Masterclass & workshop by IST, on the auspicious occasion of World Health Day-7<sup>th</sup> April 2020 at Medanta Medicity Gurugram, to learn toxicology in a day.

## Conclusion

Toxicity mapping is very important aspect of preventive toxicology. So, the Toxic map is prepared by the Indian Society of Toxicology to predict the common poisonings & call out the emergency medical services to prepare for managing the toxic disasters, based on the common toxins in that region, easily available to the vulnerable population. Among its many applications, toxicity prediction by Toxic map can reduce the cost and labor of Medical Services in the long run, by preventing the morbidity & mortality of innocent victims.

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