Occupational Health Hazards Due to Exposure in Chemical Industries, Mines & Environment

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Motto – Safety to Environment and Health and Service to Industry

- ✓ **Environmental Toxicology**
- ✓ **Food, Drug and Chemical Toxicology**
- ✓ **Nanomaterial Therapeutics & Toxicology**
- ✓ **Regulatory Toxicology**
- ✓ **Systems Toxicology and Health Risk Assessment**

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CSIR – Indian Institute of Toxicology Research

Mission – A leader in toxicology research, endeavours to mitigate problems of human health and environment

The institute aims to accomplish its goals through the following objectives:

- ✓ **Mode of action of toxic chemicals/pollutants**
- ✓ **Safety evaluation of chemicals used in industry, agriculture and everyday life**
- ✓ **Remedial/preventive measures to safeguard health and environment from pollutants**
- ✓ **Occupational health hazards due to exposure in chemicals industries, mines, agricultural fields and environment**
- ✓ **Simple/rapid diagnostic tests for diseases caused by industrial and environmental chemicals**
- ✓ **Collect, store and disseminate information on toxic chemicals**
- ✓ **Human resource development for dealing with industrial and environmental problems**
- ✓ **Provide a platform to public and entrepreneurs to address queries and concerns regarding safety/toxicity of chemicals, additives and products**

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Epidemiological Studies on Health Hazards in Industries, Mines, and Environment

- ✓ **Health Survey of Saw Mill Workers, Lucknow**
- ✓ **Health Survey of Metalware Workers, Moradabad**
- ✓ **Health Study of Workers Engaged in Local Thermal Power Station, Lucknow**
- ✓ **Health Survey of Cotton Mill Workers, Kanpur**
- ✓ **Health Study of Welders**
- ✓ **Health Examination of Tannery Wokers**
- ✓ **Bio-Monitoring for Fluorosis, Gusainganj, Lucknow**

Continued …….

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- **Monitoring of air-borne concentration of asbestos fibre content in the occupational environment of U.P. Asbestos Ltd., Mohanlalganj, Lucknow**
- **Occupational Exposure to Phosphine in Indian Workers (Collaboration with SGPGIMS, Lucknow)**
- **Health Survey of Pesticide Sprayers, Malihabad**
- **Magnitude and Usage Pattern of Artificial Synthetic dyes in Foodstuff**

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Building blocks – Living/ Non-living things

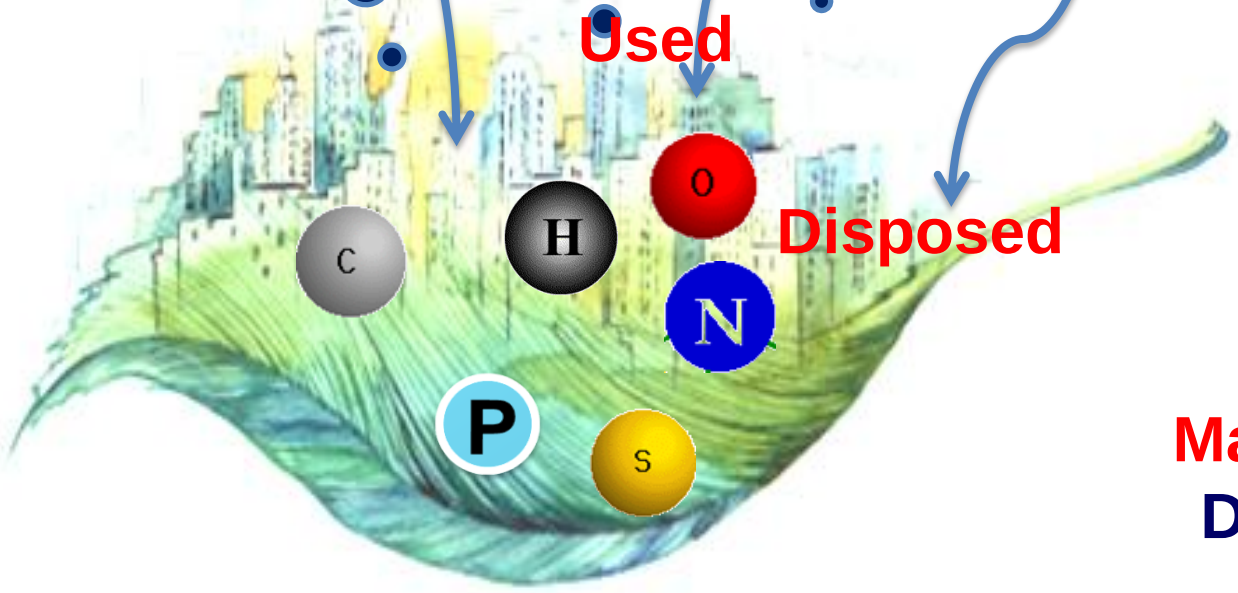
Natural/ Synthetic
Food, Fabric
Medicines
Computer
Fuel, Industries
Byproduct used chemical process

Improve the quality of life

Produced

Used

Disposed



Process

Innovation

Magnitude of Hazards

Dose/ Duration/ Age

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Environmental Chemicals

Metals

Monomers

Pesticides

Solvents

Radioactive materials

Natural and animal toxins

E-Waste

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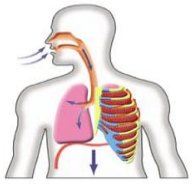
Occupational Exposure – Routes

Inhalation



Nearly all airborne materials can be inhaled

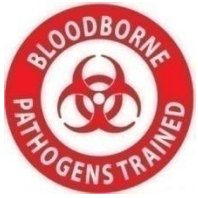
Dermal Absorption

Through contact of substance / chemicals on the skin

Ingestion

Unintentional (As most workers do not swallow materials deliberately) / Intentional

Injection



Associated with blood borne pathogens through sharp objects / needles

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Risk and Hazard – Major Difference

Risk

Chance or probability that an individual could be harmed or experience adverse health effect on exposure

Hazard

Source of potential damage, harm or adverse health effect on something or some one in a certain work condition

Risk assessment / Modeling to avoid hazards

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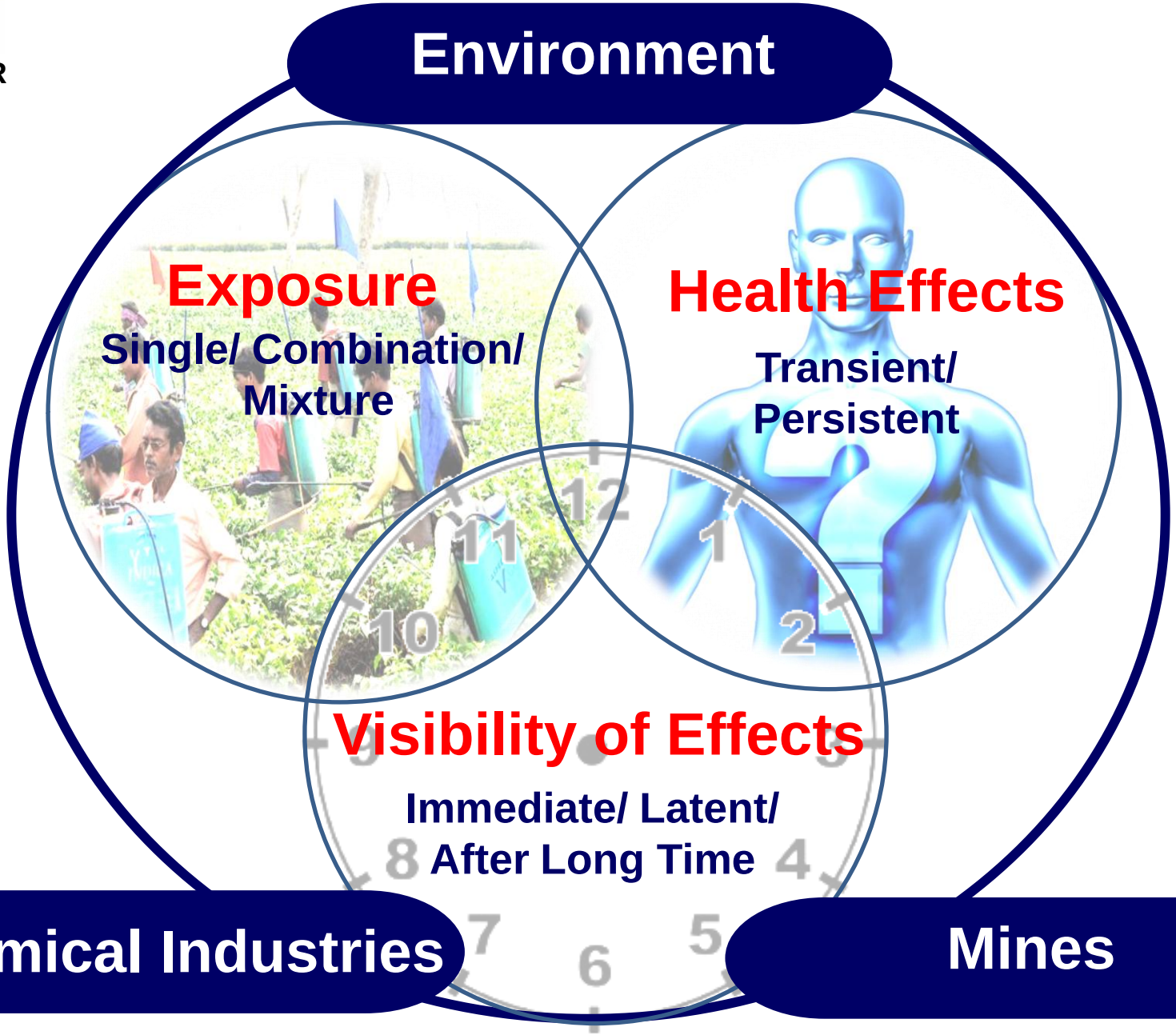
Chemical Exposure and Visibility of Effects



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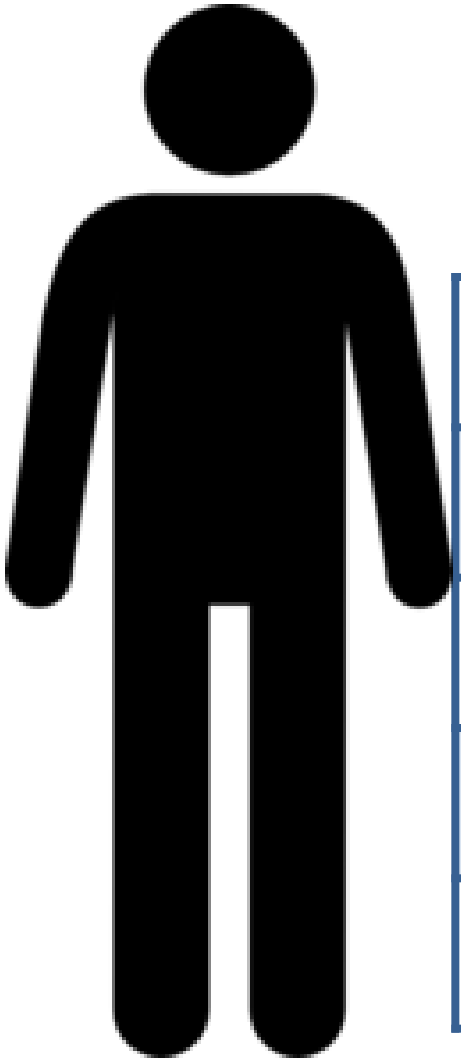
Health Hazards – Influencing Factors

Vulnerability

- Age/Gender
- Race
- Life style
- Genetic factors
- Medical history



Work place/ Exposure Conditions

- Physical properties
- Multiplicity of exposure
- Duration of exposure
- Magnitude of exposure
- Timing of exposure

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Occupational Exposure to Chemicals and Associated Health Effects

Cardiovascular Disease

Lead, Cadmium	Battery mfg. and recycling	Hypertension
Carbon disulfide	Degreasing, Dry cleaning	Atherosclerosis
Fluorocarbon, Trichloroethylene	Refrigeration, Solvent workers	Arrhythmias

Respiratory Diseases

Solvents, Ammonia	Chemical industries	Irritation, Inflammation
Inorganic dust	Mining, Coal, Construction, Sandblasting,	Pneumoconiosis
Chromium	Plating, Metal refining	Cancer

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Occupational Exposure to Chemicals and Associated Health Effects

Liver Diseases		
Carbon tetra chloride	Cleaning fluids, Dry cleaners	Acute liver toxicity
Vinyl chloride	Plastics and Vinyl chloride mfg.	Liver cancer

Skin Diseases		
Plastic epoxides	Plastic industries varnish	Allergic/ contact dermatitis
Cutting oils, Grease	Machine-tool operators	Acne
Arsenic, tar Pesticides	Petroleum refinery, Agricultural workers, Manufacturing and packaging industries	Skin Cancer

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Occupational Exposure to Chemicals and Associated Health Effects

Renal Diseases		
Mercury, Cadmium, Pesticide	Battery, chemical industries Pesticide handlers	Acute/Chronic Renal failure

Blood Diseases		
Lead	Battery mfg., Lead smelting	Anemia
Benzene	Solvent & soap mfg.	Aplastic anemia

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Occupational Exposure to Chemicals and Associated Health Effects

Nervous System Disorders		
Mercury	Thermal power plants, Ore processing	Headache, Dizziness Memory loss, Insomnia, Anxiety
Pesticides	Agriculture, Manufacturing and packaging industries	Neurobehavioral abnormalities, Impaired motor functions, Cognitive deficits
Lead	Battery workers, Paint industries, Glass industries	Wrist drop, Muscular weakness, Seizures, Tremors, Low IQ (children)
Cadmium	Battery workers, Paint industries, Glass industries	Impaired motor functions Learning disabilities

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Occupational Exposure to Chemicals and Associated Health Effects

Nervous System Disorders		
Arsenic	Production of alloys, refining of lead and copper, pesticides, semiconductors, electroplating	Impaired verbal comprehension and long term memory Slurred language Auditory damage PNS, Low IQ in children
Manganese	Mining, welding, Ferro-alloy industries, alkaline batteries, Mn-based pesticides	Abnormal gait Hallucination Manganism Parkinsonism Heightened aggressive behavior

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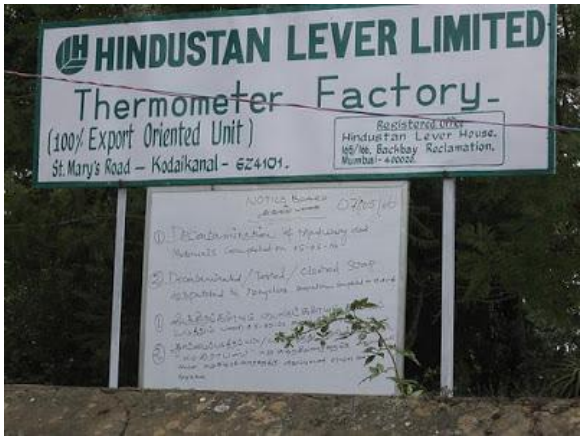
Mercury poisoning - Kodaikanal



One of the popular tourist attraction of Tamil Nadu; Shola forests of Western Ghats famous for carpets of green grasslands

1983 – Chesebrough Pond's relocated Thermometer factory from Watertown, NY (later acquired by HUL in 1986)

Residential locality; Eco-sensitive area

2001 – Residents and environmental groups uncovered a dump site – 7.4 ton stockpile of crushed mercury containing glass, spilled on the ground in scrap yard

Also dumped mercury containing waste in the part of the Shola forests in company premises

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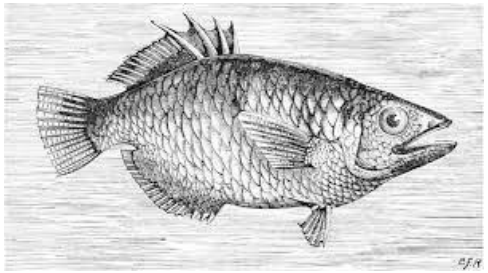
Mercury poisoning in Kodaikanal - Environmental Contamination

Department of Atomic Energy –

Kodaikanal lake contamintated with mercury (Dispersal of elemental mercury to atmosphere and water through effluents from the factory)

Mercury levels

	Kodaikanal lake	Berijam lake
Moss and Lichens	7.9 – 8.3 ug/kg	0.2 ug/kg
Fish	120 – 290 mg/kg	-



Just 1g mercury disposed may contaminate the lake (25 acre) and its inhabitant – unfit for human consumption

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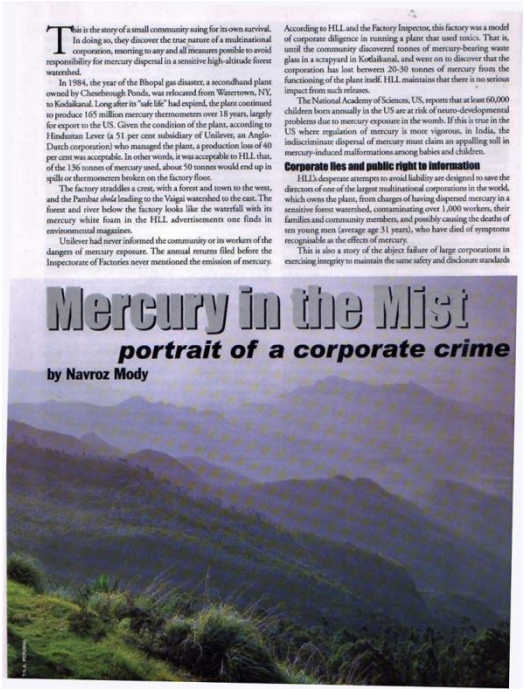
Mercury poisoning in Kodaikanal – Health effects



This is the story of a small community suing for its own survival. In doing so, they discover the true nature of a multinational corporation, resorting to any and all measures possible to avoid responsibility for mercury dispersal in a sensitive high-altitude forest watershed.

In 1984, the year of the Bhopal gas disaster, a secondhand plant owned by Chesebrough Ponds, was relocated from Watertown, NY, to Kodaikanal. Long after its "safe life" had expired, the plant continued to produce 165 million mercury thermometers over 18 years, largely for export to the US. Given the condition of the plant, according to Hindustan Lever (a 51 per cent subsidiary of Unilever, an Anglo-Dutch corporation) who managed the plant, a production loss of 40 per cent was acceptable. In other words, it was acceptable to HLL that, of the 136 tonnes of mercury used, about 50 tonnes would end up in spills or thermometers broken on the factory floor.

The factory straddles a crest, with a forest and town to the west, and the Pambar *shola* leading to the Vaigai watershed to the east. The forest and river below the factory looks like the waterfall with its mercury white foam in the HLL advertisements one finds in environmental magazines.

Unilever had never informed the community or its workers of the dangers of mercury exposure. The annual returns filed before the Inspectorate of Factories never mentioned the emission of mercury.

According to HLL and the Factory Inspector, this factory was a model of corporate diligence in running a plant that used toxics. That is, until the community discovered tonnes of mercury-bearing waste glass in a scrapyard in Kodaikanal, and went on to discover that the corporation has lost between 20-30 tonnes of mercury from the functioning of the plant itself. HLL maintains that there is no serious impact from such releases.

The National Academy of Sciences, US, reports that at least 60,000 children born annually in the US are at risk of neuro-developmental problems due to mercury exposure in the womb. If this is true in the US where regulation of mercury is more vigorous, in India, the indiscriminate dispersal of mercury must claim an appalling toll in mercury-induced malformations among babies and children.

Corporate lies and public right to information

HLL's desperate attempts to avoid liability are designed to save the directors of one of the largest multinational corporations in the world, which owns the plant, from charges of having dispersed mercury in a sensitive forest watershed, contaminating over 1,000 workers, their families and community members, and possibly causing the deaths of ten young men (average age 31 years), who have died of symptoms recognisable as the effects of mercury.

This is also a story of the abject failure of large corporations in exercising integrity to maintain the same safety and disclosure standards

Mercury in the Mist

portrait of a corporate crime

by Navroz Mody

Over 1,100 workers in the factory; Unaware of the risks and dangers while handling mercury

No safety equipments, No proper facilities to cleanup after working, No face masks that could reduce the intake of mercury from air

Contract workers handling the mercury with bare hands during the clean up; Family members also exposed through them

Initially – Headache, Skin rashes, Spinal problems

Environmental mercury – Kidney, Liver, Eyes, Brain, Reproductive system and Birth defects

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Mercury poisoning in Kodaikanal – Health effects

Preliminary Health check up – 2 Occupational and Community Health Specialists from Bangalore

30 Workers and ex-workers

- **Gum and dental problems**
- **Mood swings and nervous disorders**
- **Skin allergies**

Medical health check up sponsored by company –
Ruled out associated health problems with mercury exposure

18 ex-workers, 09 children of former workers died due to illness

Miscarriages, congenital abnormalities, physical and mental disorders reported in many workers – Associated with mercury exposure

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Mercury poisoning in Kodaikanal – Ultimate Fate

2001 – Factory closed 18 years after operation

2003 – TNPCB ordered to send back the dumped mercury waste (289 ton) to US for recycling and disposal

2004 – The SC Monitoring Committee ordered the company to clean the contaminated site and surrounding area.

TNPCB permitted to dispose of equipments in the contaminated area

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Endosulfan disaster - Kasargod

- ✓ An organochlorine pesticide used in agriculture and allied sectors
- ✓ US EPA – Highly hazardous category, Considered as POP, Banned in many countries
- ✓ 1976 – 2000 - The Plantation Corporation of Kerala (PCK), sprayed endosulfan aerially on cashew plantations over an area of 12000 acres in 9 villages of Kasargod district three times a year to eradicate tea mosquitoes
- ✓ Over 50,000 villagers of the Kasargod district exposed; Over 3,000 people living near downstream and downwind were affected by debilitating diseases
- ✓ NHRC mandated the NIOH, Ahmedabad to investigate the isuue – Aerial exposure associated with health problems

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Endosulfan Disaster – Health Impacts

Physical and behavioral disorders
Cardiovascular diseases
Sensory loss
Neurological ailments
Congenital Anomalies
Dermatological and Musculoskeletal disorders

Environmental studies – Presence of endosulfan in soil, water, sedinments, cashew leaves

Biological studies – Concentration of endosulfan, levels of hormones – growth, thyroid and reproduction

Epidemiological studies – Assess the disease burden, incidences of selected diseases

CSE, New Delhi; NIOH, Ahmedabad, KAU, Thiruvananthapuram

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Endosulfan – Problem of Disposal

- Remaining endosulfan stored in HDPE drums
- HIL has come up with new technology to neutralize stored endosulfan (1,600 litres) in Kasargod – Operation Bloosom Spring (following the norms of FAO)
- To come up with a clear and effective plan to dispose remaining stock of endosulfan in Kasargod

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A Study by NIOH, Ahmedabad

Effects of Endosulfan

- Absorbed through skin
- Gets into humans mostly through water and food
- Affects central nervous system, kidneys, liver and reproductive system

A study by the National Institute of Occupational Health has linked the pesticide to higher prevalence of neurobehavioural disorders, congenital malformations in female children and abnormalities in male reproductive systems in Padre village of Kasaragod district.

Results of medical survey

Disease	Sprayed area	Non-sprayed area
Congenital anomalies	95	70
Mental retardation	97	83
Cancers	58	34
Infertility	104	75
Repeated abortions	22	2
Growth retardation	25	11
Movement disability	67	04
Epilepsy	37	37
Psychiatric problems	46	33
Other problems	54	0

(Source : State Health Department)

http://hindu.com/2005/07/11/stories/2005071108720400.htm

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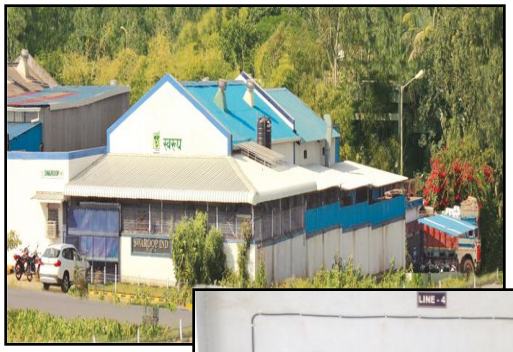
An Example - Pesticides Exposure



Single, Short term
High level exposure
Accidental / Suicide

Long term
High level exposure
Pesticide Formulation and Manufacturers

Long term
Low level exposure
Individual / General population through contamination

Similar / different problems at different places

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Occupation Exposure in Miners

- A crucial economv sector that includes utilization of metallic and non-metallic minerals
- Indian mining sector – Daily employment – 5,60,000; 87% (4,90,000) in public sector and 13% (70,000) in private sectors
- Ranking in the globe – 2nd – Chromite, barites and talc; 3rd – coal and lignite, 4th in iron ore (2002-2003)
- Regularly exposed to dust of potential pollutants and toxicants – chromium, lead, mercury, cadmium, maganese, aluminum, fluoride, arsenic etc.
- Occupational health assessment of chromite toxicity among Indian miners– AP Das and S Singh, Indian J. Occupational Environ. Med. 15, 6-13, 2011 (Data compiled by OSHA, Odisha SPCB and Odisha VHA used to asses the risk of diseases among SukIndia chromite miners)

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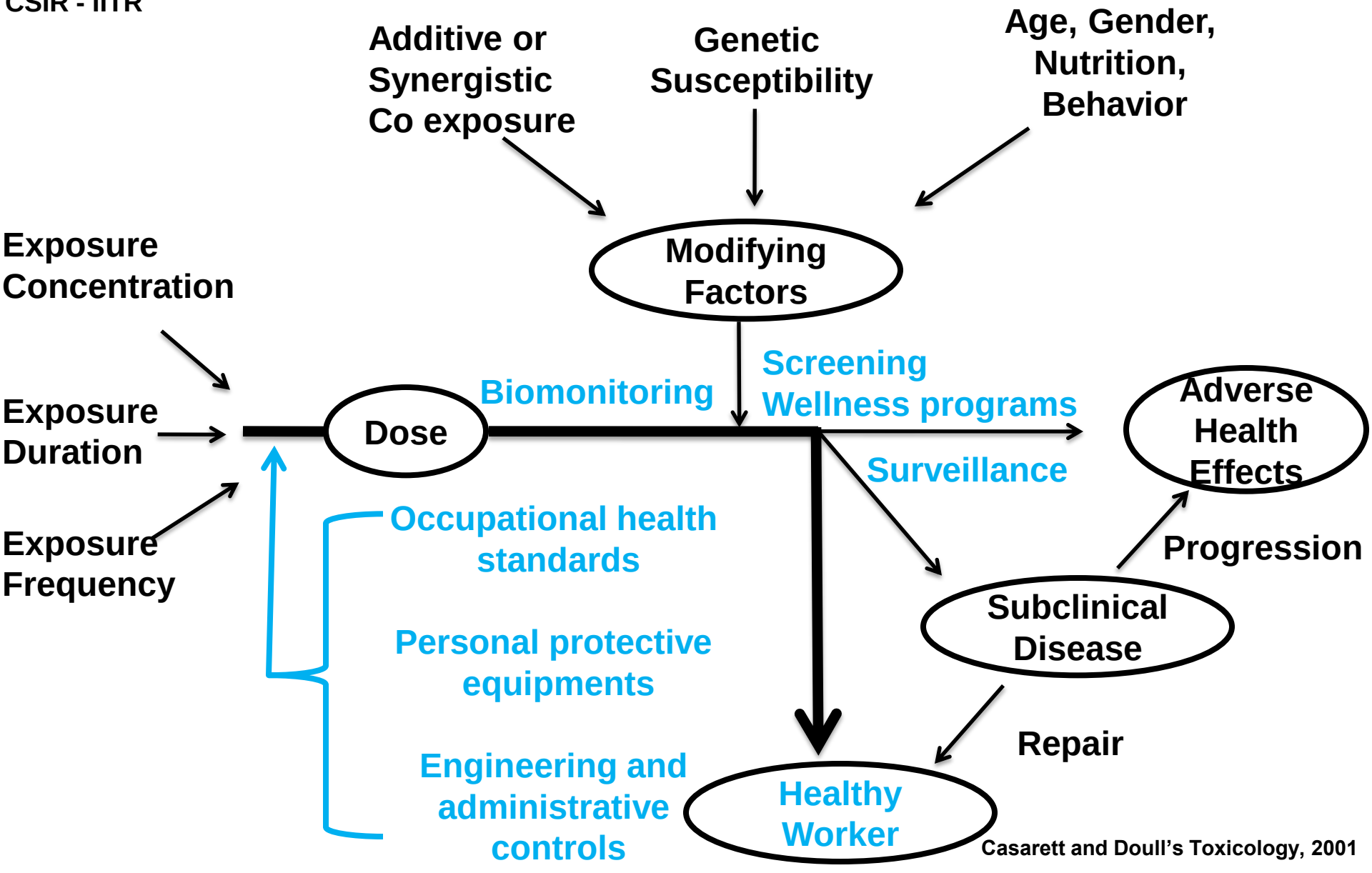
Pathways from exposure to disease – Modifying factors and opportunities for intervention



Casarett and Doull's Toxicology, 2001

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Recommendations

- ✓ Periodical monitoring and determination of chromium concentrations in work area
- ✓ Characterization and quantification of toxic Cr (VI) in mine environment be studied
- ✓ Regular health checkup of workers (estimation of Cr (VI) in body fluids and tissues)
- ✓ Create awareness among the workers to protect them by training and educational programmes

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Medical Surveillance

Know the hazard	How worker is exposed ? How worker is affected ?
Characterize the hazard	Exposure levels Exposure duration
Know the worker	Susceptibilities
Obtain information on medical examinations	Directed towards specific organ system
Analyze Medical Data	Disease, recovery, rehabilitation Effectiveness or failure of control measures

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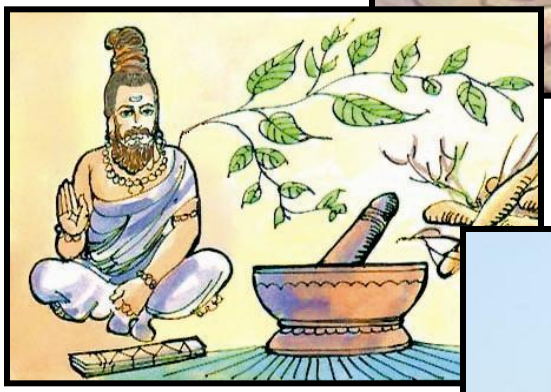
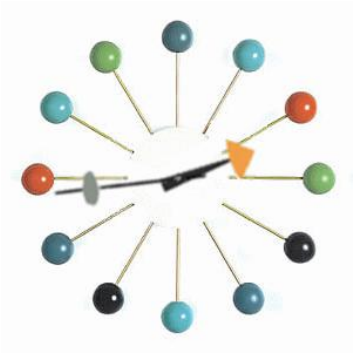
How Prepared We Are ?





- ✓Planning
- ✓Prevention
- ✓Preparedness
- ✓Response
- ✓Recovery

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Acknowledgements

Rajendra K. Shukla

Pranay Srivastrava

References –

http://toxtown.nlm.nih.gov/text_version/chemicals.php

and http://nim.nih.gov

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