

E-waste and children's health

TRAINING FOR HEALTH CARE PROVIDERS

[Date ...Place ...Event...Sponsor...Organizer]

**Electrical/Electronic
Waste and Children's Health
DRAFT**

Children's Health and the Environment

WHO Training Package for the Health Sector

World Health Organization

www.who.int/ceh

LEARNING OBJECTIVES

- ❖ Know the definition of e-waste, where it originates and how it moves around the world.
- ❖ Learn about potential toxic hazards associated with end of life management of e-waste (e-waste disposal, material recovery, open burning and formal/informal recycling), what they are, and the risks they may pose to children and young workers.
- ❖ Identify the exposure scenarios – how, where and when are children at risk?
- ❖ Be able to suspect diseases that may be related to acute and chronic exposures to chemicals present in e-waste or generated during recycling.
- ❖ Learn about international initiatives and proposed local interventions to prevent children's toxic exposures.

OVERVIEW

- ❖ Origin, processes and circumstances of environmental risks related to e-waste
- ❖ Children: settings and routes of exposure
- ❖ Identification of most common hazardous chemicals potentially released
- ❖ Evidence of exposure and effects
- ❖ Prevention of exposure and poisoning

E-WASTE DEFINITIONS

❖ *Multiple definitions, examples: _*

OECD

“any appliance using an electric power supply that has reached its end-of-life”

(UNEP 2007)

EUROPEAN COMMISSION

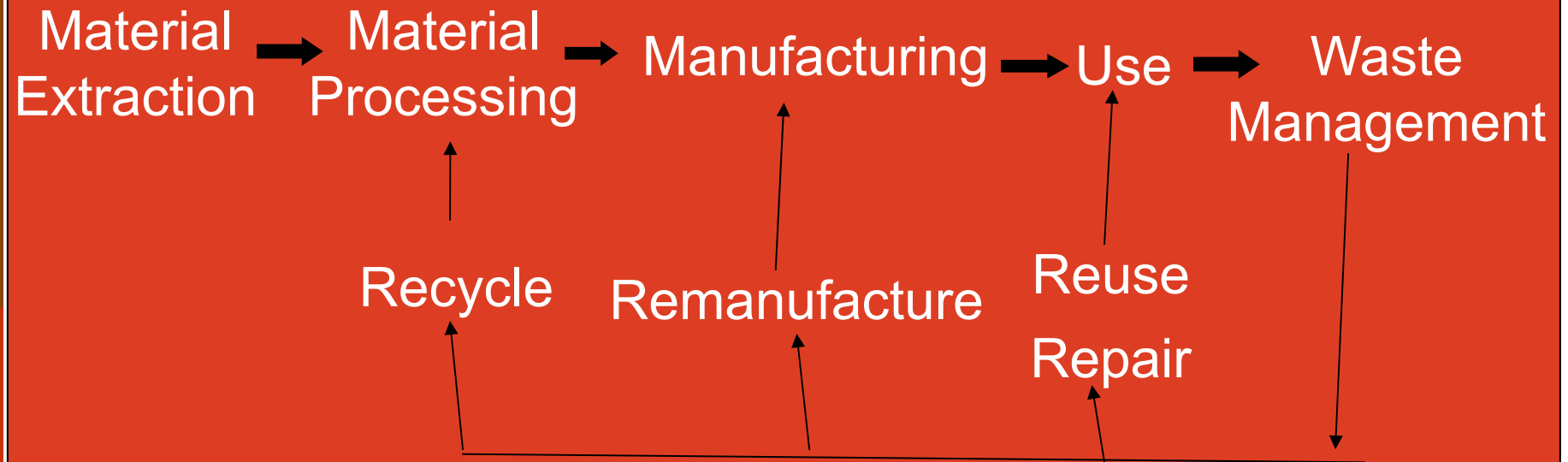
“waste electrical and electronic equipment (WEEE) including all components, sub-assemblies and consumables, which are part of the product at the time of discarding”

(Commission Directive 2002/96/EC)



Canelones Department - Uruguay, Picture by Dra. Raquel González

LIFECYCLE OF ELECTRONICS



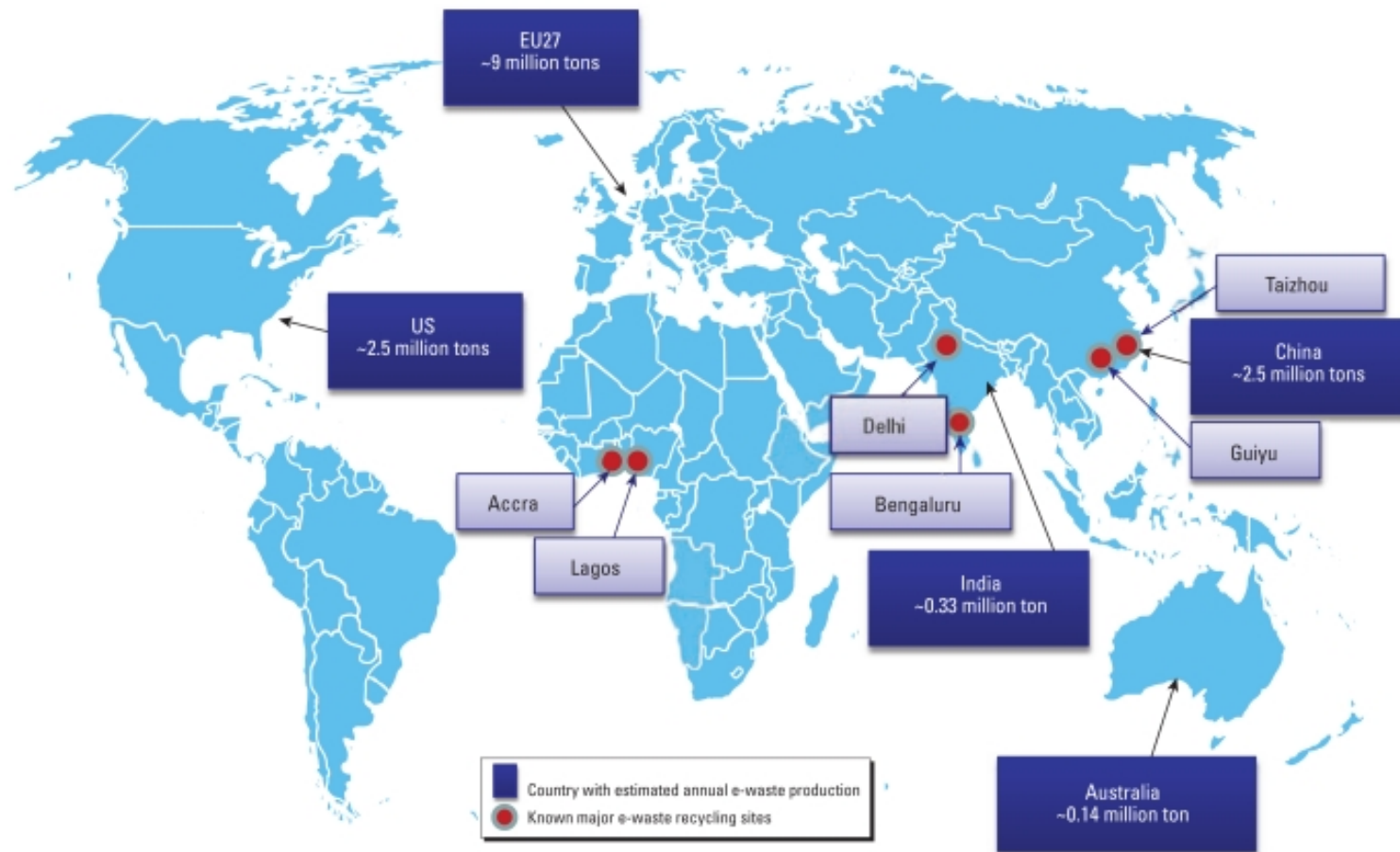
E-WASTE

- ❖ Electrical and electronic waste (e-waste), is a fast growing solid waste stream
- ❖ About 40 million tonnes of e-waste are created globally each year.
- ❖ Secondary products and waste may be invisible to the production statistics.
- ❖ Complex and sometimes illegal e-waste trade goes to developing countries.



E-waste and children's health

ESTIMATED ANNUAL GENERATION OF E-WASTE AND MAJOR RECYCLING SITES - EXAMPLES



Chen A et al.: Developmental neurotoxicants in e-waste: an emerging health concern. *Environmental Health Perspectives* (2010), 119(4):431–438; doi: 10.1289/ehp.10024

E-WASTE AS A SOURCE OF VARIOUS CHEMICALS

- ❖ E-waste is a source of a variety of materials that can be recovered and brought back into the production cycle.
- ❖ Over 1,000 different chemicals are identified in the e-waste streams.
- ❖ Heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and brominated flame retardants, such as polybrominated diphenylethers (PBDEs), plus a number of plastics components.



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ELECTRICAL AND ELECTRONIC WASTE

- ❖ Monitors/computers/motherboards
- ❖ Telephones/mobile phones
- ❖ Chips
- ❖ Wireless devices/other peripheral items
- ❖ Printers, fax/photo copy machines
- ❖ Televisions
- ❖ Cathode ray tubes
- ❖ Transformers
- ❖ Audio - stereo equipment/video cameras
- ❖ Cables
- ❖ Lamps
- ❖ Large household appliances (e.g., refrigerators)



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E-WASTE AND ENVIRONMENTAL POLLUTION

Environmental pollution may be associated with...

PRIMITIVE

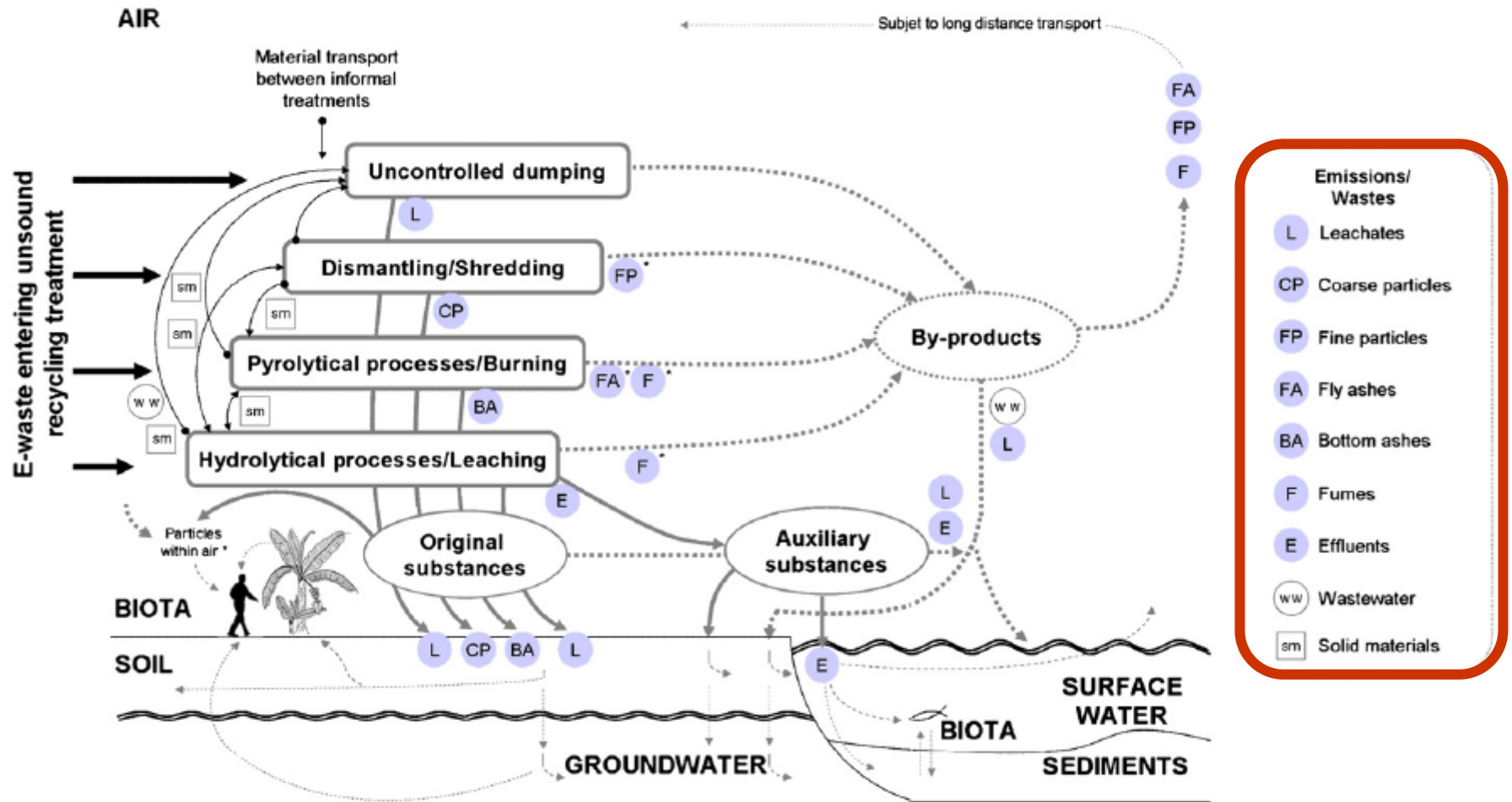
Open Burning
Practice

Recycling &
Recovering

Landfilling

E-waste and children's health

SUBSTANCES RELEASED: ENVIRONMENTAL PATHWAYS



(Sepúlveda et al., 2010)

TYPICAL CONTAMINATION SCENARIOS

- ❖ Dumping sites at or near riverbanks
- ❖ Villages situated along rivers that receive e-waste
- ❖ Manually disassembling and repairing
- ❖ E-waste open burning to extract valuable metals
- ❖ Final disposal sites or landfills



DINAMA. G. Medina

E-WASTE AND HEALTH RISKS

E-waste materials are not only a source of environmental contamination but may also pose significant human health risks if improperly managed



WHO

HAZARDOUS EMISSIONS FROM INFORMAL RECYCLING PRACTICES

- ❖ Leachates from dumping activities
- ❖ Particulate matter (coarse and fine particles) from dismantling activities
- ❖ Fly and bottom ashes from burning activities
- ❖ Fumes from “cooking”, desoldering, and other burning activities
- ❖ Wastewater from dismantling and shredding facilities
- ❖ Effluents from leaching activities
- ❖ Evaporation of substances
- ❖ Revolatilization of chemicals from soil



DINAMA. G. Medina

SOURCES OF CHILD EXPOSURE AT HOME AND SURROUNDINGS


- ❖ Recovering and recycling are often rudimentary in house or backyard operations
- ❖ Primitive recycling procedures through open cable burning, acid baths, and “cooking” circuit boards
- ❖ Home-based and family-run recycling activities



SECA



SECA

- 
- ❖ Injury risk
 - ❖ High levels of mixtures of chemicals contained in the materials

SETTINGS OF CHILD EXPOSURE

- ❖ Children involved in burning activities and manual dismantling
- ❖ Children living in or close to houses with recycling activity
- ❖ Children manually sorting and picking of recyclable, reusable materials from mixed wastes
- ❖ Take home exposure from parents working with e-waste e.g. contaminated dust



Ceppi, Corra

PAHO

ROUTES OF CHILD EXPOSURE

- ❖ Contamination of the surrounding areas, soil, home surfaces (e.g. windows sills), water
- ❖ Atmospheric pollution due to burning and dismantling activities
- ❖ Inhalation of indoor or outdoor fumes
- ❖ Ingestion of:
 - Contaminated dust and soil
 - Contaminated drinking water
 - Contaminated food



ROUTES OF PERINATAL EXPOSURE

- ❖ Mother's intake and body burden is transferred across the placenta and through breast milk
- ❖ Breast milk represents

"The very top of the food-chain."

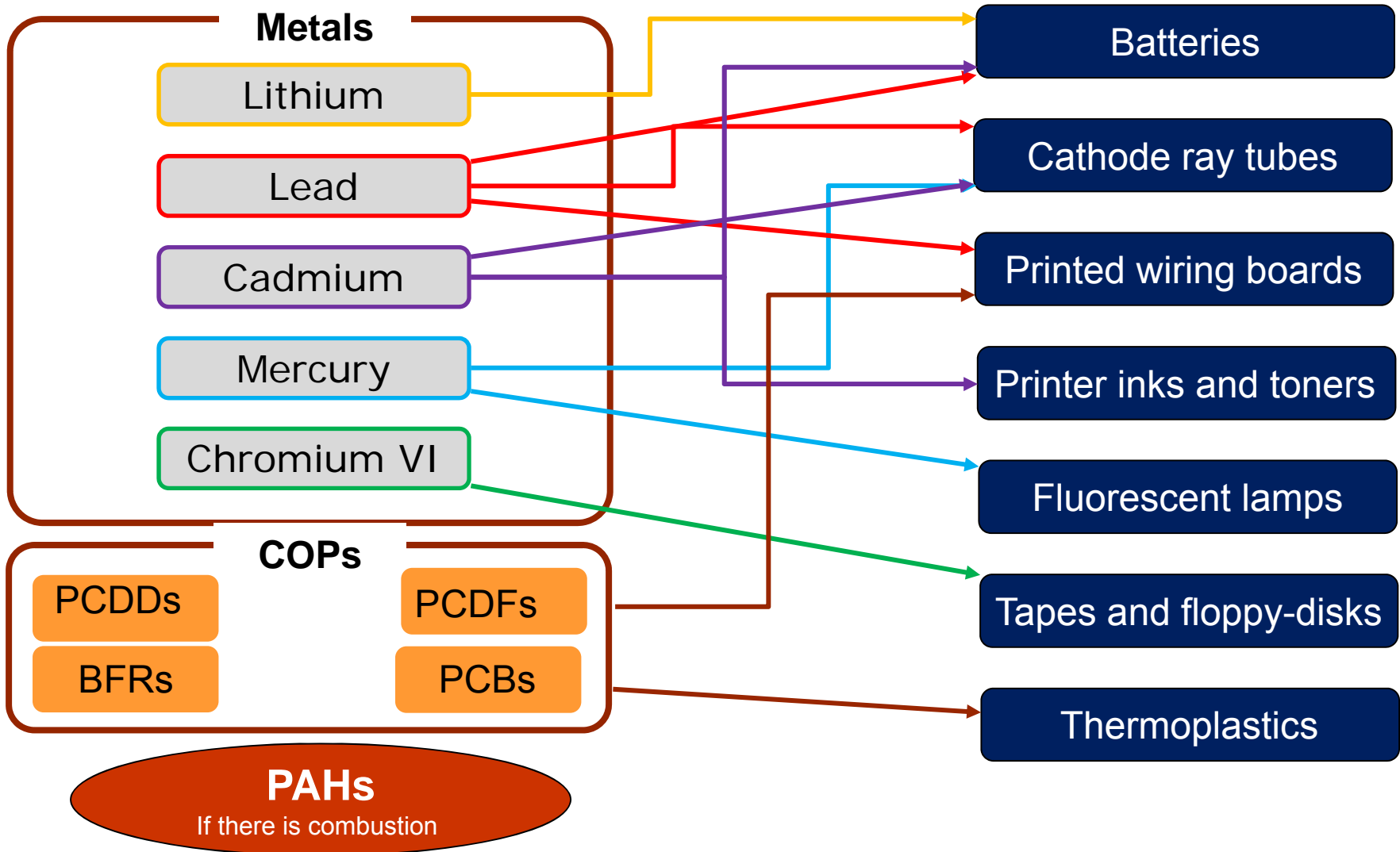
- ❖ Note: In spite of the presence of contaminants WHO promotes breastfeeding as the optimal food for babies



WHO

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COMMON TOXICANTS RELEASED FROM E-WASTE UNSOUND ACTIVITIES



UNIQUE CHARACTERISTICS OF E-WASTE TOXICANT EXPOSURES

- ❖ Children's e-waste toxicant exposure depends on
 - Type of e-waste
 - Length of recycling history
 - Amount of e-waste recycling
 - Specialization in recycling process
 - Locations of the workshops
 - Parental involvement in recycling
 - Daily activities of the child

- ❖ Exposure to e-waste lasts a long time
 - Many recycling sites have operated for more than a decade
 - Pregnant women who grew up at the site would have higher exposure history than women who moved in at the time of marriage
 - Exposures to male men may affect spermatogenesis and lead to transgenerational effects



WHO

LEAD

- ❖ Cathode Ray Tubes (CRTs) - found in older desktop computers and television sets - contains the greatest amount of all substances of concern, such as 2–3 kilograms of lead in each device.

Significantly higher proportion of elevated blood level ($BLL \geq 10 \mu\text{g/dL}$) and correlation between placenta levels of lead (Pb) was found in residents of an e-waste recycling town in comparison to a non exposed neighbouring population.

CADMIUM

- ❖ Common metal in mobile phone batteries
- ❖ Surface mount devices chip resistors
- ❖ Infrared detectors
- ❖ Semiconductor chips

High levels of placental and cord blood cadmium and the resulting expression of placental metallothionein were significantly associated with environmental exposure to cadmium in an e-waste recycling town.

MERCURY

- ❖ Fluorescent lamps
- ❖ Some alkaline batteries
- ❖ Mercury wetted switches
- ❖ All the mercury annually used in electrical and electronic equipment accounts for about 22 % of the world mercury consumption

Environmental and occupational mercury exposure has been associated with nephrotoxicity and neurological, cardiovascular and immune system alterations. Further research is needed to report mercury levels in populations with e-waste recycling activities.

POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

- ❖ Product of incomplete open air combustion and dumping of processed e-waste materials contaminate air, soil, and sediment with high concentrations of PAHs
- ❖ Concentrations of 16 priority PAHs in suspended particles (TSP) and PM_{2.5} may be 10 and 20-fold greater in e-waste recycling areas than that at high transit-density cities

Maternal PAHs exposure in e-waste sites results in fetal accumulation of toxic PAHs and adverse effects on neonatal health, particularly reduced neonatal height and gestational age.

DIOXINS AND FURANS

- ❖ Open burning and acid leaching releases the largest amounts of dioxins and furans
- ❖ The body burdens of dioxins in people from an e-waste processing site were ranked among the highest when compared to an international basis
- ❖ Infants from e-waste polluted areas consume at least 25 times the WHO tolerable daily intake (TDI) (1-4 pg TEQ/kg body weight/day) compared to non e-waste polluted areas

MULTIPLE TOXIC EFFECTS AND INTERACTIONS

❖ Additive effect

- Common mode of action (PCDD/Fs – PAHs: antagonism of aryl hydrocarbon receptors)
- Oxidative stress: POPs
- Common target: Metals (Hg, Pb, Mn, Al)
- Allergic reactions. Metals
- Carcinogenic potential: Cr(VI), As, PAHs
- Endocrine disruption: POPs
- Immune suppression : POPs

❖ Persistence and bioaccumulation (eg: POPs, Hg) in animals and products

MULTIPLE TOXIC EFFECTS ON CHILD HEALTH AND DEVELOPMENT

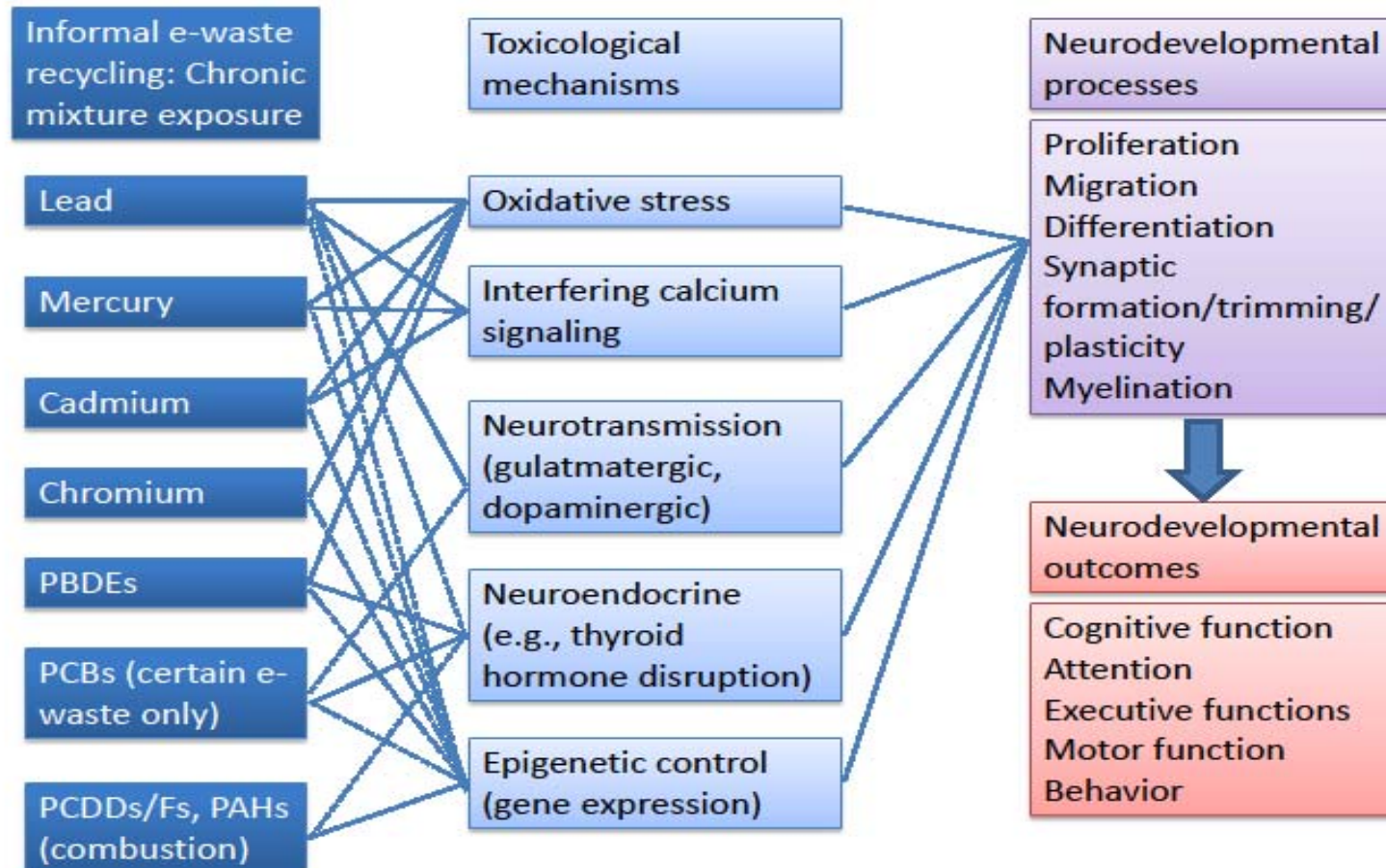
- Neurodevelopmental deficits
- Damage to the blood and cardiovascular systems
- Respiratory diseases
- Skin problems
- Gastric diseases



WHO

E-waste workers suffer high incidences of birth defects and infant mortality.

MULTIPLE NEUROTOXICANTS



HEALTH OUTCOMES: A SYSTEMATIC REVIEW BY WHO AND WHO COLLABORATING CENTERS

- ❖ Alterations in thyroid function
- ❖ Associations between exposure to chromium, manganese and nickel; and lung function
- ❖ Reproductive health: adverse birth outcomes (preterm birth, low birth weight, stillbirth, and congenital malformations)
- ❖ In e-waste exposed populations height and weight were significantly lower than control population
- ❖ Mental health outcomes: behavioral alterations
- ❖ Alterations in cellular levels and function: DNA damage and chromosomal aberrations in lymphocytes

CHALLENGES TO TACKLE E-WASTE ISSUES

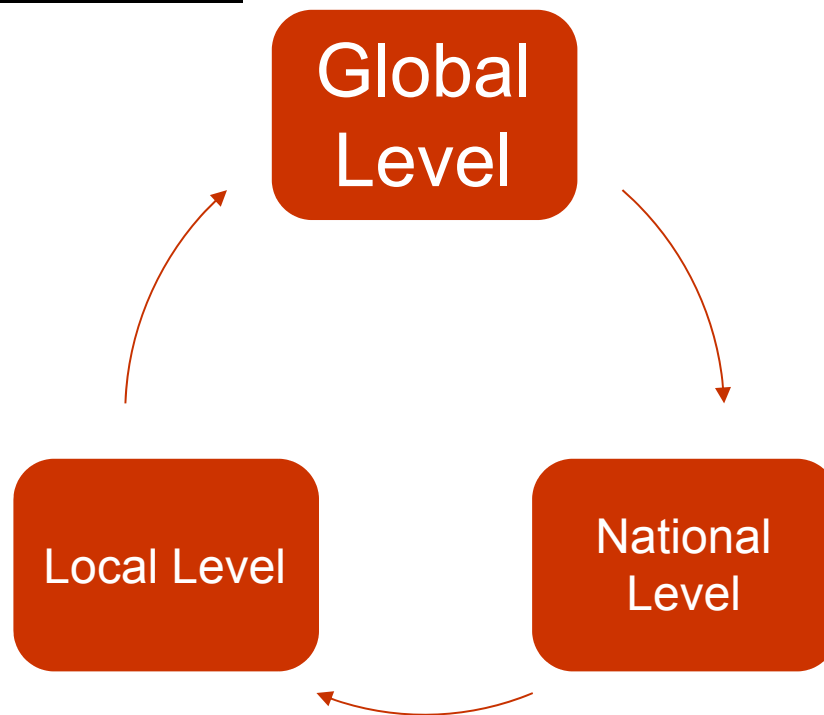
- ❖ Information on exposure is limited
- ❖ Children are the most vulnerable
- ❖ Long-lasting low dose exposure may cause diseases after many years
- ❖ Effects occur through a mixture of chemicals and different mechanisms
- ❖ There is high evidence of the toxicity of chemicals involved in e-waste contamination
- ❖ Social vulnerability in the genesis and persistence of the exposure



WHO

WHAT CAN BE DONE TO PREVENT CHILD E-WASTE EXPOSURE?

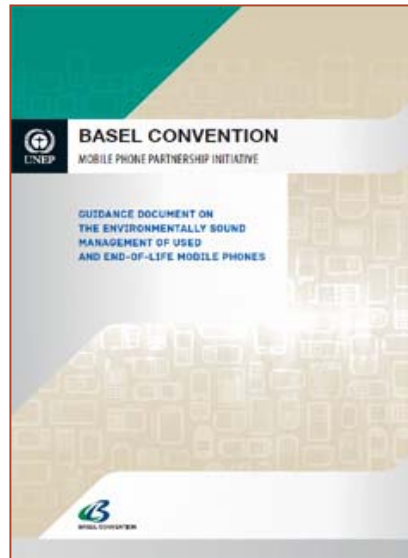
Take action at:



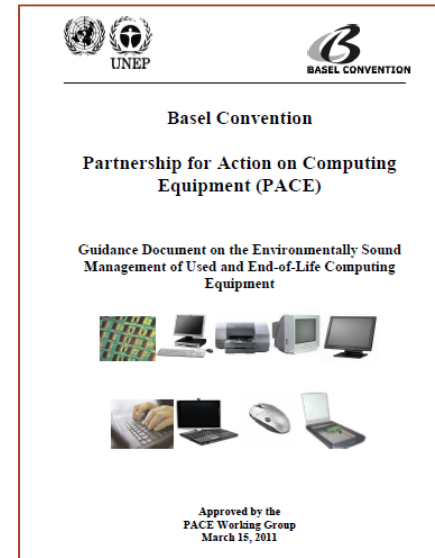
WHO

GLOBAL LEVEL: INTERNATIONAL AGREEMENTS AND TOOLS FOR ACTION

- ❖ Basel Convention (1989)
 - Controlling transboundary movements of hazardous wastes and their disposal
- ❖ Rotterdam Convention (1998)
 - Prior informed consent procedures for certain hazardous chemicals and pesticides in international trade
- ❖ Stockholm Convention (2001)
 - Protecting human health and the environment from persistent organic pollutants (POPs)



Guidance Document on the Environmentally Sound Management of Used and End of Life Telephones (2008)



Guidance Document on the Environmentally Sound Management of Used and End-of-Life Computing Equipment (2009)

EXAMPLES OF INTERNATIONAL INITIATIVES

- ❖ Electronic Waste Initiative (UNIDO, 2004)
- ❖ Solving the E-Waste Problem (StEP, 2007)
- ❖ Partnership for Action on Computing Equipment (PACE, 2008)
- ❖ E-waste and child health initiative (WHO, 2013)



NATIONAL LEVEL

- ❖ Risk management
- ❖ Response to international agreements
- ❖ Implement standards, actions and programmes on e-waste toxicant exposures
- ❖ Improve downstream monitoring of e-waste
- ❖ Reuse and minimization waste policies
- ❖ “Take back” programs
- ❖ Maximize design for repairability, reuse and durable use
- ❖ Reduce the use and release of e-waste
- ❖ Reduce toxicity: phase-out certain chemicals
- ❖ Erradícate child labour within e-waste

LOCAL LEVEL

- ❖ Promote good practices in the process of recovery and recycling
- ❖ Invest in better solutions for recyclability and ease of disassembly
- ❖ Educate the community and workers
- ❖ Educate health care providers
- ❖ Surveillance and epidemiological vigilance for acute and chronic related illness

HEALTH CARE PROVIDERS PLAY A KEY ROLE

- ❖ Identifying the problem
- ❖ Diagnose exposure and treat health effects
- ❖ Defining its local determinants and characteristics
- ❖ Educating colleagues and other professionals
- ❖ Informing the community – and the children
- ❖ Raising the awareness of policy-makers
- ❖ Promoting the implementation of the appropriate measures
- ❖ Helping to evaluate the efficacy of preventive measures
- ❖ Surveillance of exposure and effects.



WHO

ROLE OF HEALTH CARE PROVIDERS THE PEDIATRIC ENVIRONMENTAL HISTORY SUSPECTING EXPOSURE TO E-WASTE

- ❖ Include questions regarding e-waste disposal, recycling, recovery and open burning, in the Pediatric Environmental History (green page)
- ❖ Observe e-waste processes , e-waste dumping sites or ashes from past burning when visit homes

DATOS SOBRE SITUACIÓN AMBIENTAL INFANTIL - HOJA VERDE (Formato A4x60)			
Nombre del paciente:	Domicilio:	Fecha:	Número de historia clínica:
Sexo:	Fecha de nacimiento:	Profesional evaluador:	
Con qué habita?:	Ambito de vida:		Otros datos:
Se encuentra en situación de trabajo?	- Rural - Urbana - Peri-Urbana		
CONSTRUCCIÓN: - Vivienda - Escuela o Guardería - Área de recreación - Comunidad			
ZONA GEOGRÁFICA			
ALIMENTOS			
CALIDAD DE AIRE			
CALIDAD DE AGUA			
TIPO Y CALIDAD DE SUELO			
DISPOSICIÓN DE EXCRETAS			
DISPOSICIÓN DE BASURA			
RUIDO			
QUÍMICOS			
TRANSITO			
Expresa la madre preocupación por un factor ambiental? Cuál(es)? Porque?			
Existen problemas ambientales reconocidos en el área? Cuáles?			
En que trabaja la madre y/o el padre? Describe			
Existe exposición a animales parásitos/vectores? Cuáles?			
Hay presencia de animales domésticos? Cuáles?			
Hay presencia de vectores de enfermedades? Cuáles?			
Hay exposición a temperaturas extremas? Describe			
Fue el niño(a) víctima de accidente de tránsito? Describe			
Ha sufrido quemaduras, u otros lesiones? Cuáles?			
Hubo exposición a algún incidente químico? Cuál(es)?			
Hay antecedente de intoxicación química y/o alimentaria? Describe?			
Observaciones (otros datos)			

ORGANIZACIÓN MUNDIAL DE LA SALUD 1

SUSPECTED EXPOSURE

- ❖ Apart from lead in blood, other pollutants may be difficult to measure in developing countries

Chemicals	Matrix	Units
PCDD	Serum Breast milk	pg/g lipid
Polycyclic aromatic hydrocarbon (PAH)	Urine	ug/l
PAH metabolites (1OH Pyrene)	Urine	ug/g creatinine
Cadmium (Cd)	Serum Urine	ug/l ug/g creatinine
Polybrominated diphenyl ethers (PBDE)	Serum Breast Milk	ng/g lipid

CASE STUDIES: GUIYU, CHINA

- ❖ The town of Guiyu in China is the most studied e-waste town.
- ❖ Elevated heavy metals (e.g. lead) levels.
- ❖ Residents of Guiyu have reported of children suffering from breathing ailments, skin infections, and stomach diseases compared to neighboring population non e-waste exposed towns/cities.
- ❖ It has been described as the largest e-waste recycling site in the world.
- ❖ About 100,000 people are engaged in this activity, representing about 80 percent of the town's population.

CASE STUDIES: AGBOGBLOSHIE, GHANA

- ❖ Agbogbloshie scrap market located in Accra is the main center for the recovery of materials from e-waste.
- ❖ Concentrations of Fe, Sb, and Pb in urine of e-waste recycling workers were significantly higher than those of reference sites after consideration of interaction by age, indicating that the recycling workers are exposed to these multi-trace elements through the recycling activity.
- ❖ Personal air samples collected from workers and the environment revealed elevated levels for Al, Cu, Fe, Pb and Zn.
- ❖ Of 100 soil samples taken, more than half were above the US Environmental Protection Agency standards for lead in soil.

WERE THE LEARNING OBJECTIVES REACHED?

- ❖ Learn about chemical hazards in children – what they are and what are the risks they may pose?
- ❖ Identify the scenarios – how, where and when are children exposed?
- ❖ Be able to suspect diseases that may be related to acute and chronic exposures to chemicals present in e-waste or generated during recycling
- ❖ Learn about international initiatives and proposed actions to prevent children's toxic exposures

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