ELECTRICAL/ELECTRONIC WASTE AND CHILDREN’S HEALTH

TRAINING FOR HEALTH CARE PROVIDERS

Children’s Health and the Environment
WHO Training Package for the Health Sector
World Health Organization
www.who.int/ceh

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Notes:
• Please add details of the date, time, place and sponsorship of the meeting for which you are using this presentation in the space indicated.
• This is a large set of slides from which the presenter should select the most relevant ones to use in a specific presentation. These slides cover many facets of the problem. Present only those slides that apply most directly to the local situation in the region.
Image:
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Note:
This presentation deals with children exposed to chemicals contaminated in air, soil, dust, food, or water due to emissions or effluents from electrical and electronic waste recycling activities where health care providers are called to play a key role.

Learning objectives

- Understand the definition of e-waste, where it originates and how it moves around the world
- Recognize potential toxic hazards and the risks they may pose to children
- Learn about exposure scenarios – how, where and when children are at risk
- Learn about diseases that may be related to acute and chronic exposures to chemicals in e-waste
- Consider international actions and local interventions to prevent children’s toxic exposures
Outline

- Definition of e-waste and magnitude of the problem
- Environmental origin, transport and fate of waste toxicants
- Mechanisms of toxicity and health effects
- Case studies: China, Ghana, Uruguay
- Management and prevention

Note:
When selecting the slides to include in your presentation, please choose only those of relevance to the region and/or interests of your audience.

This training module includes:
- Definitions of e-waste, scale of issues, and geographic routes of exposure.
- Environmental origin of e-waste hazards, informal recycling processes leading to emissions, and overview of exposures in children.
- Mechanisms of action, target organs and systems affected from e-waste exposure.
- Case studies from Guiyu, China; Agbogbloshie, Ghana; and Montevideo, Uruguay.
- Management and prevention, including international initiatives, regulatory measures, and local actions at community level and medical domain).
Outline

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# Definition of e-waste

<table>
<thead>
<tr>
<th><strong>EUROPEAN COMMISSION</strong></th>
<th>“waste electrical and electronic equipment (WEEE) including all components, sub-assemblies and consumables, which are part of the product at the time of discarding”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEP INITIATIVE</strong></td>
<td>“electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use”</td>
</tr>
</tbody>
</table>

**Notes:**

There is no standard definition of e-waste. The most widely accepted definition of e-waste is per the European Commission: “waste from electrical and electronic equipment (WEEE) and it includes all components of electronic equipment, any subassemblies and consumables which are part of the product at the time it is discarded”.

The Solving the E-waste Problem (StEP) initiative defines e-waste as “electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use”.

End of Life Equipment is defined as “individual equipment that is no longer suitable for use, and which is intended for dismantling and recovery of spare parts or is destined for material recovery and recycling or final disposal. It also includes off-specification or new equipment which has been sent for material recovery and recycling, or final disposal”.

**References:**


**Image:**

- © Federico Magalini
Magnitude of the problem

- E-waste is a fast-growing solid waste stream
- 44.7 million metric tonnes of e-waste are generated annually
- Up to €55 billion in resources could be recovered annually from properly recycled e-waste
- Complex and sometimes illegal e-waste trade goes to developing countries in order to extract valuable materials
- Children exposed to improperly managed e-waste experience multiple toxic effects which impact their health and development

Notes:
Each year millions of electric and electronic devices are discarded as consumers buy new products. The discarded devices are considered electronic waste (e-waste) becoming an environmental and human threat.

The amount of e-waste generated in 2016 was estimated to be 44.7 Mt (million metric tonnes). This is equivalent to 6.1 kg of e-waste per person each year. Furthermore, the amount of e-waste is expected to increase to 52.2 Mt by 2021. Of note, secondary products and waste may be invisible to production statistics.

The United Nations University estimated that in 2016, up to €55 billion in resources could have been retrieved from e-waste if all materials were properly recycled. Thus, it is a valuable commodity and can be the means for individuals’ and even communities’ livelihoods.

The e-waste trade is complex and international organizations are working on how best to define trade conditions and the difference between donations of usable equipment and export of waste electronics. Despite international regulations targeted to control the transport of e-waste to developing countries, transboundary movements are still unknown. Only 20% of e-waste is documented as being properly collected and recycled. Most of the remaining 80% is likely dumped, traded or recycled under inferior conditions. E-waste transport is a complex task because in some cases electronic equipment are traded in the form of donations to needy communities.

References:
Notes:
The United States of America, countries in Western Europe, China, Japan, and Australia are the major e-waste producers. In the last 10 years e-waste has been increasing in Eastern Europe and Latin America.

Primitive recycling of e-waste has been reported to occur in Asia (China, India, Vietnam) and Africa (Ghana, Nigeria). In other countries (Brazil, Colombia, Kenya, Mexico, Morocco, Peru, Senegal, South Africa, Uganda), there exist small-scale, informal e-waste recycling operations. Recycling activities in developing countries include recovering gold, silver, copper, zinc, iron, tin, and other metals. In Latin American countries, several families live for decades in landfills. Evidence suggests that e-waste recycling and other informal activities represent the largest source of family financial support for economically disadvantaged families.

References:

Figure:
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E-waste as a source of chemicals

- Over 1000 chemicals have been identified in e-waste streams
  - Heavy metals
  - Polycyclic aromatic hydrocarbons (PAHs)
  - Polychlorinated biphenyls (PCBs)
  - Brominated flame retardants
    - Polybrominated diphenylethers (PBDEs)
  - Some plastics components

Notes:
E-waste activities may cause potential exposure to a complex mixture of over 1000 chemicals, and the toxicity and environmental properties of these chemicals have not been thoroughly investigated.

Most of these chemicals of concern have a slow metabolic rate in animals and may bio-accumulate in tissues. Thus, they can be excreted in edible products such as eggs and milk. Likewise, e-waste-related toxic effects can be exacerbated throughout a person’s lifetime and across generations.

References:
Examples of e-waste sources

- Computers, monitors and motherboards/chips
- Wireless devices and other peripheral items
- Printers, copiers and fax machines
- Telephones and mobile phones
- Video cameras
- Televisions
- Stereo equipment
- Cathode ray tubes
- Transformers
- Cables
- Lamps
- Large household appliances

Notes:
Although not exhaustive, the following list shows some forms of electrical and electronic equipment.

Peripheral items: any auxiliary device that connects to a computer, such as a mouse or keyboard
Large household appliances: refrigerators, washers, dryers

References:

Images:
© WHO (left) and WHO/Heba Farid (right)
Several hazardous chemicals are present in waste from electrical and electronic equipment (WEEE). Chromium (VI) is found in data tapes and floppy-disks; cadmium is found in printer inks and toners of photocopy-machines; barium and mercury are found in fluorescent lamps; cadmium, barium, mercury, zinc, nickel and lead are found in cathode ray tubes; cadmium, nickel, lithium and lead are found in batteries; and lead is found in printed wiring boards.

In addition to the above, persistent organic pollutants (POPs) are also found in e-waste from printed wiring boards and thermoplastics. If there is combustion, polycyclic aromatic hydrocarbons (PAHs) may also be released. About 16 US EPA priority PAHs and POPs such as brominated flame retardants (BFRs) have been identified in e-waste. Examples for BFRs in e-waste are: polybrominated biphenyls (PBBs), tetrabromobisphenol-A (TBBP-A) and 22 different PBDE congeners.

Furthermore, 36 non-dioxin-like polychlorinated biphenyl (NDL PCB) congeners have been identified as e-waste components. 

17 different polychlorinated dibenzo-p-dioxins (PCDDs), 12 dioxin-like polychlorinated biphenyl (DL PCB) congeners, as well as polychlorinated dibenzofuran (PCDF) congeners, and up to 16 different PAHs have been identified as being released during e-waste combustion.

References:

Figure:
Notes:
Improperly managed e-waste materials may pose significant human and environmental health risks. In some areas, large quantities of e-waste are discarded, sometimes in river banks. Equipment is usually manually disassembled, working pieces are repaired and marketed, and useless materials end up in dumpsites or landfills. Primitive recycling of e-waste includes open burning of printed circuit boards (boards that connect electronic components in electronic devices), cables and plastics; stripping or burning wires to recover copper; plastic chipping and melting; as well as heating and acid leaching of circuit boards, memory banks or chips to extract gold and palladium. Burning circuit boards by hand is referred to as “cooking” circuit boards. Primitive recycling procedures through open cable burning, acid baths, and “cooking” circuit boards are considered the most hazardous scenarios.

Reference:
Notes:
If improperly managed, substances may pose significant human and environmental health risks. The hazards associated with placing e-waste in landfills are due to the variety of substances they contain. The main problem in this context is the leaching and evaporation of hazardous substances. Besides the leaching of substances in landfills, there is also a risk of vaporization of volatile hazardous substances. For example: for mercury, both the leaching and vaporization of metallic mercury and methylated mercury are of concern. Dimethyl mercury, an organic form of mercury, was detected in landfill gases at levels 1000 times higher than what has been measured in open air. Open burning is apparently the main source of poly-halogenated dioxins and furans and emissions of metal fumes.

References:
Notes:
Children participate in the manual sorting and picking of recyclable, reusable materials from mixed wastes. Working as a waste picker is considered One of the Worst Forms of Child Labour. In addition, children are involved in burning discarded electronics and in manually dismantling them into component parts. In developing countries children can serve as a source of cheap labour: their small hands give them an advantage in dismantling products. Informal recycling practices expose workers to high levels of toxicants from spending time in landfills or through the poor ventilation in indoor facilities, even home-based activities. Dismantling and burning e-waste can result in toxic airborne particles and fumes inhalation, direct skin exposure to corrosive agents, ingestion, or burns.

Even when children are not involved in child labour, they may be exposed to pollutants at home, where e-waste recovery and recycling often takes place. Home-based and family-run recycling using primitive procedures such as open cable burning, acid baths, and “cooking” circuit boards puts children at risk of both injury and exposure in their own home or backyard. Parents who engage in e-waste recycling work outside the home (especially “acid baths” and “burning to recover metal residues” works) may also take lead contaminated dusts home and increase the chances of lead exposure to children.

Regardless of their own occupations or parents’ occupations, children who live near recycling sites are exposed to e-waste hazards throughout the environment. Rudimentary recycling techniques, coupled with the amounts of e-waste processed, result in adverse environmental and human health impacts, including air, soil and surface water contamination. Children play outdoors and sometimes in landfills, making them particularly vulnerable to environmental contamination. E-waste materials are not only a source of environmental contamination but may also pose significant human health risks if improperly managed.

References:
• Heacock M, Kelly CB, Asante KA, Birnbaum LS, Bergman A, Bruné Drisse MN et al. (2016). E-waste and harm to

Notes:
Exposure occurs through contaminants in the soil, home surfaces (e.g. window sills, shelves) and water, which can be inhaled or ingested. Frequent hand-to-mouth behaviour in younger children can increase exposure to chemicals from dust or play items.

In villages situated along the rivers where piles of e-waste are disposed and burned, people use the river water directly for drinking, cooking and washing. One example is Guiyu, China, a major e-waste hotspot. Levels of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in some fish of Guiyu river exceeded the EU's maximum allowable concentration in fish muscle (4 pg WHO-TEQ/g wet weight), so the intake of PCDD/Fs via freshwater fish consumption in this place may exceed the higher end of the tolerable daily intake recommended by the World Health Organization (WHO), European Commission-Scientific Committee on Food (EC-SCF) and Joint FAO/WHO Expert Committee on Food Additives (JECFA), 1–4, 2 and 2.3 pg WHO-TEQ/kg body weight/day, respectively.

Dioxins and dioxin-like PCBs are chemicals with different degrees of dioxin-like toxicity. The use of Toxic Equivalency Factors (TEFs) allows concentrations of the less toxic compounds to be expressed as an overall equivalent concentration of the most toxic dioxin, 2,3,7,8-TCDD. These toxicity-weighted concentrations are then summed to give a single concentration expressed as a Toxic Equivalent (TEQ).

References:

Image:
• © Federico Magalini
Notes:
Exposure of children and pregnant women to lead, mercury, cadmium and other heavy metals can cause serious neurological damage to the child. Chemicals can cross the placenta and contaminate breast milk. Transplacental and lactational exposure is expected for most metals and lipophilic organic pollutants in e-waste. Breast milk represents the very top of the food-chain.

Note: WHO promotes breast-feeding as the optimal food for babies, in spite of the presence of contaminants in it.

Pregnant women who grew up in recycling sites would have a longer exposure history and higher body burden in physiologic deposits (i.e. bones and adipose tissues) than that of women who moved in at the time of marriage. Exposures to men may affect spermatogenesis and lead to transgenerational effects. Exposure is seen during gestation and even among neonates in many studies comparing populations that work with e-waste to those that do not.

References:

Image:
• © WHO/Petterik Wiggers
Evidence of perinatal exposure

- A significantly higher proportion of blood lead level >10 μg/dL and was found in residents of an e-waste recycling town in comparison to a non-exposed neighbouring population.
- High levels of placental and cord blood cadmium as well as their downstream effects were significantly associated with environmental exposure to cadmium in an e-waste recycling town.
- Maternal PAH exposure in e-waste sites results in fetal accumulation of toxic PAHs and adverse effects on neonatal health, particularly in reduced neonatal height and gestational age.

Notes:
Studies in Guiyu, China, show that environmental pollution resulting from informal e-waste recycling activities may contribute to elevated exposure in populations living nearby.

High placental lead concentrations have been reported in studies of women residing near e-waste recycling areas, with positive correlations between Pb levels and both parents’ length of residence in the area and the father’s e-waste-related work. Prenatal lead exposure is associated with adverse outcomes (e.g., neurodevelopment alterations).

Exposure to e-waste recycling pollutants increased cadmium exposure in neonates, which was accompanied by increased placental metallothionein (MT) expression as cadmium is a potent inducer of MT synthesis. MT is a protein involved in zinc homeostasis and metabolism; thus, cadmium exposure due to e-waste may result in alterations in these functions.

Combustion of e-waste has been shown to result in high concentrations of PAHs in air, soil, and sediment in Guiyu. Infants experienced adverse birth outcomes, correlated with prenatal exposure and fetal accumulation of toxic PAHs: benzo[a]anthracene (BaA), chrysene (Chr), and benzo[a]pyrene (BaP).

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Notes:
Clarification of mixture effects is challenging in toxicology as interaction among substances can be additive due to simultaneous exposures. Known effects and interactions include:

Persistent organic pollutants and other chemicals from e-waste activities generate oxidative stress. They can also cause endocrine disruption and immune suppression.

Neurotoxic metals like Al, Hg, Mn and Pb found in e-waste and are emitted from burning and acid leaching. Exposure to metals can also lead to allergic reactions.

Antagonism with the aryl hydrocarbon receptor (AhR) is a common mode of action for dioxin-like compounds, like PCDD/Fs, Dioxin-like PCBs (DL-PCBs) and PAHs. The toxic equivalency factor (TEF) is applied to dioxin-like substances (PCDD/Fs and DL-PCBs) that share this common mode of action (AhR antagonism), although they differ in potency (dose-response curve).

Carcinogenic effects are associated with Cr(VI), As, and PAHs.

Many chemicals bioaccumulate, such that a multiple toxins may be present in the body and in food.

References:
Multiple toxic effects on child health and development

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

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

Notes:
Health effects include skin, stomach and respiratory disease. High rates of birth defects, infant mortality, tuberculosis, blood diseases, immune system anomalies, renal and respiratory malfunction, lung cancer, neurodevelopmental deficits in children and nervous and blood system damage affect e-waste workers. About 80% of children in Guiyu are estimated to suffer from respiratory diseases, and the number of leukaemia cases in the e-waste hotspot has increased. E-waste recycling activities have also been reported to contribute to elevated blood lead levels in children, skin damage, headaches, vertigo, nausea, chronic gastritis and gastric and duodenal ulcers.

References:
Notes:
This slide shows different neurotoxicants found in e-waste, which children living or working near e-waste sites may be chronically exposed to, often in combination. Arrows link neurotoxicants to their toxicological mechanisms in children. The following slide details how these mechanisms affect neurodevelopment.

References:

Figure:
Notes:
Neurotoxic interaction among many of the e-waste activities emissions, and neurodevelopmental outcomes. The previous slide showed the e-waste exposures that are linked to each toxicological mechanism displayed. This diagram details how the neurotoxic interactions from those e-waste activity emissions result in neurodevelopmental outcomes.

References:

Figure:
Health outcomes
A systematic review by WHO and WHO collaborating centres

- Alterations in thyroid function
- Associations between lung function and exposure to chromium and nickel
- Adverse birth outcomes
  - Preterm birth, low birth weight, stillbirth and congenital malformations
- Decrease in height and weight
- Behavioural alterations
- DNA damage and chromosomal aberrations in lymphocytes

Notes:
Grant et al. (2013) identified a total of 23 studies reporting associations between exposure to e-waste/WEEE and physical health outcomes, including: thyroid function, reproductive health, lung function, physical indexes, and alterations to normal cell functioning. Although all studies investigated the link between exposure to e-waste/WEEE and outcomes, the chemical components of e-waste/WEEE analyzed differed between studies and included: PBDEs, PCDD/F, PAHs, PCBs (including dioxin-like PCBs), PFAs, and chemical elements (Cr, Pb, Mn, Ni). Outcomes were reported from Southeast China, from Guiyu, Taizhou and Luqiao. Ecological, informal and formal exposure routes were involved.

References:
Notes:
The toxicity of many individual substances found in e-waste is well documented, however, the toxicity of the mixtures of substances likely to be encountered through e-waste recycling is less well known.

Effects of chemicals depend upon i) toxicity, ii) dose, iii) timing and iv) amount of exposure, and could be cumulative through generations.

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Case study: Guiyu, China

- The town of Guiyu in China is the most studied e-waste hotspot.
- E-waste was processed through informal recycling with uncontrolled methods.
- About 100,000 people were engaged in this activity, including 5,500 individual family workshops.
- Children were exposed to e-waste hazards during recycling activities and while living near contaminated sites.

Notes:
Guiyu had been described as the largest e-waste recycling site in the world. About 100,000 people were employed in this activity, representing about 80% of the town’s population. People engaged in recycling processed about 2 Mt of e-waste per year, often using informal and uncontrolled methods. Recycling activities included manual dismantling, circuit board baking, gold acid bathing, and burning of cables and plastic. Children were directly exposed during the recycling processes and consistently while living near contaminated sites.

In 2011-2012, the family workshops were closed and a centralized dismantling area built. E-waste could no longer be dismantled in residential areas and had to be dismantled in the prescribed centralized dismantling area. See photos of remediation on slide 50. Since that time, the environment has visibly improved.

References:
Notes:
Informal recycling is related to environmental pollution and human exposure. Evidence of environmental contamination is shown in several studies performed in Guiyu. Soils and plants are highly contaminated with toxic PAHs, PCBs, PBDEs and heavy metals. A recent study showed that geometric mean concentrations of PM2.5, Pb and Cd were higher in Guiyu than concentrations in the reference area. The metal concentrations in PM2.5 from Guiyu were also higher when compared to concentrations in other Asian cities. Higher levels of metals were found in cord blood of newborns and also in children exposed to e-waste in Guiyu, compared to levels found in neighbour populations.

References:

Images:
• © Xia Huo
Health Effects

Notes:
Residents of Guiyu have reported that their children suffer from breathing ailments, skin infections, hair loss, tumours, headaches and stomach diseases.

Reference:

Images:
• © Xia Huo
Notes:
Children from Guiyu were found to have elevated blood lead levels relative to children in a reference group. Levels have dropped since remediation in 2011-2012.

References:

Images:
• © Xia Huo

Figure:
• © Xia Huo
Case study: Agbogbloshie, Ghana

Agbogbloshie scrap market, located in Accra, is the main centre for the recovery of materials from e-waste.

Much of this activity is carried out by young men, mostly using rudimentary tools and without protective equipment.

Notes:
Accra, population 4 million, is the capital of Ghana and the country’s largest hub for industry, infrastructure and manufacturing. It is also home to Agbogbloshie scrap market, the main centre for materials recovery from e-waste that is increasingly making its way to West Africa. The young men who carry out most of this work do so with rudimentary tools and without protective equipment.

Reference:

Photos:
• © Federico Magalini. Cables burning activities in Agbogbloshie. Used with copyright permission.
Studies suggest that e-waste workers in Agbogbloshie are exposed to multi-trace elements through their work.

Urine samples taken from e-waste recycling workers in Agbogbloshie were found to have significantly higher concentrations of iron, antimony and lead compared to levels in a reference site, after controlling for age effects.

Personal air samples collected from e-waste workers and the environment revealed levels of Al, Cu, Fe, Pb and Zn above ACGIH TLV guidelines and US EPA standards.

Of 100 soil samples taken at Agbogbloshie, more than half (56) were above US EPA standards for lead in soil. 84 samples exceeded US EPA standards for lead in soil in children’s play areas.

Blood calcium and lead levels in Agbogbloshie e-waste workers has also been found to be higher than levels in background populations. Blood lead levels for 67.2% of those sampled also exceeded the US CDC/NIOSH guideline. Urinary arsenic from the same e-waste workers was also found to be elevated compared to reference populations; levels in 39% of those sampled also exceeded the US ATSDR guideline for arsenic in urine.

References:
Case study: Montevideo, Uruguay

Open cable burning in order to obtain copper is a significant source of lead exposure, especially harmful to children and adolescents who participate in these activities.

Notes:
In Uruguay, open cable burning has been performed for over a decade in order to obtain copper from e-waste. Montevideo, the capital, is the site of more than half of burning activities in the country. Burning is a significant source of lead exposure, which is especially harmful to children and adolescents employed in primitive recycling procedures and living nearby.

A study performed in Montevideo analysed the blood lead levels of children and adolescents in low income families exposed to lead through burning cable activities.

Reference:

Images:
- © Amalia Laborde. Cables and circuit boards burning in an urban zone of Montevideo. Used with copyright permission.
Montevideo, continued

- Blood lead levels among children and adolescent exceeded the limit for medical intervention.
- Highest lead levels were found among the youngest children.
- Soil lead levels exceeded the US EPA standard for lead in soil in children’s play areas.
- There was a significant association between higher BLLs and high soil lead levels.

Notes:
The study of 69 children and adolescents showed an average blood lead level (9.19 µg/dL) that exceeded the current CDC-recommended level (5µg/dL) suggesting the need for medical intervention. The highest lead levels were found among the youngest children, possibly related to their habits and hand-to-mouth behaviour.

Soil lead levels measured for 40 of the study participants (mean 7103.48 mg/kg) were above the US EPA standard for lead in soil in children’s play areas (400 mg/kg). A significant association was found between higher BLLs and high soil lead levels, supporting an indirect environmental exposure pathway for children.

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Notes:
This photo captures a scene of waste management from Brazil. In Brazil, many cities rely on informal recycler’s associations based on neighbourhood. Living and recycling spaces are one and the same, and children play, pass through and spend their vacations in these areas following their parents. Many of these places receive raw material, without prior separation, as can be seen in the photo.

Image:
• © Ana Maria Carmadelo
Notes:
Long-lasting low dose exposure may cause disease after many years. There is high evidence of the toxicity of chemicals involved in e-waste contamination. Social vulnerability exists in the genesis and persistence of exposure.

Concern over e-waste has been viewed as a growing problem for around 15 years. In 2006, the Eighth Meeting of the Conference of the Parties (COP8) of the Basel Convention adopted the Nairobi ministerial declaration on the environmentally sound management of electronic and electrical waste.

Two major categories of interventions are management of existing e-waste exposures and prevention of future exposures. Health care providers can play a major role in both categories: by screening target populations for exposures, taking the environmental history, posing key questions about e-waste, and monitoring environmental exposure results for management; and by advocating for the adoption of international agreements, championing national policy initiatives, and promoting good e-waste practices on the local level for prevention.

References:
Notes:
The evaluation of the interventions require baseline and post-intervention data. Environmental monitors in the form of hand-held devices are fast and efficient. Levels of contamination in soil, water, and air should be measured. Monitoring should include PM2.5, metals, POPs and PAHs. Occupational monitoring includes working space air and dust measurement, depending on recycling conditions.

Continued on next slide with biomonitoring

References:

Photo:
Notes:
Epidemiological studies using biomarkers or chemical identification have given some guidance for public health interventions, although not all chemicals identified in e-waste have threshold values or reference levels. This table features several examples. Except for lead exposure, biomarkers are not good tools for individual diagnosis but can be used to confirm exposure. Moreover, identified pollutants may be difficult to measure in biological samples due to technical reasons (very low levels of detection, very expensive technology).

References:
Notes:
Screening should be performed on populations at risk of e-waste exposure: recyclers, their families, and those living in nearby communities. There are many different epidemiological contexts, regions and countries, which screening should be tailored to.

Target sites where there is:
- Evidence of contamination in the form of history/data, e.g. home visits or environmental and occupational monitoring
- Medical records, e.g. paediatric environmental history, “green page” [see next slide]
- Information on e-waste exposure from questionnaires, such as workers, those living in home recycling sites, and those living adjacent to e-waste sites

Different clinical tools are available to risk assessment (e.g. paediatric environmental history, screening questionnaires).

Image:
- © WHO/EURO
The Paediatric Environmental History
A role for health care providers

- Incorporate the “green page” into the standard medical history
- Include questions regarding e-waste disposal, recycling, recovery and open burning
- When visiting homes, observe e-waste processes, dumping sites and ashes from past burning

Notes:
The paediatric environmental history (PEH) is a set of questions – part of the standard medical history – that focuses on the different environments of the child. It is both a tool (set of questions) and an opportunity for interaction.

A tool for:
- identifying and assessing children’s exposure to environmental threats in the different places (e.g. e-waste).
- responding with the right therapeutic and preventive measures – as only a good knowledge of potential sources of exposure will guide an appropriate medical diagnosis and treatment.
- increasing the knowledge base – as the data collected in a harmonized manner, with controlled terminology and definitions will generate a valuable database of knowledge and facilitate research.

Reference:

Image:
- © WHO/CEH
Key questions
That health care providers can ask

- Do you know about any pollution problems in your neighbourhood?
- Do you know if cables or other materials are burned nearby?
- Does anyone recycle electrical or electronic devices in your home or surroundings?
- Do any of your neighbours or even house mates have elevated blood lead levels?

Notes:
Key questions can be asked by health care providers
Health monitoring
For health care providers to follow

- Be aware of monitoring results performed by government agencies
- Examine key questions in medical records in order to detect indoor or backyard recycling activities
- Track the results of biomonitoring for hazardous chemicals identified in e-waste streams
- Contact Poison Control Centres or Paediatric Environmental Units for toxicosurveillance

Notes:
Government agencies may test local soil, water and food for e-waste exposures; be aware of these results. Use the green page to look out for local e-waste activities.
What can be done to prevent child e-waste exposure?

Take action at:

- National Level
- Local Level
- Global Level

Notes:
Because of the potential for long-term damage to critical structures such as the nervous system, immune system and endocrine system, prevention of all exposure events, as well as exposure to low doses during development is a high priority for ensuring children’s environmental health. There are many steps that can be taken at the local/practice level, national/government level and international treaty/trade levels to decrease exposures to toxic chemicals and prevent related illnesses.
Global level: International agreements and tools for action

Basel Convention, 1989
• Control of transboundary movements of hazardous wastes and their disposal

Rotterdam Convention, 1998
• Prior informed consent procedure for certain hazardous chemicals and pesticides in international trade

Stockholm Convention, 2001
• Measures to reduce or eliminate the release of POPs into the environment

Minamata Convention, 2013
• Treaty to reduce mercury emissions and releases of mercury and mercury compounds

Notes:

The Basel Convention controls the transboundary movement of hazardous wastes and their disposal. It is a comprehensive environmental agreement in relation to tackling the issues surrounding e-waste and its management. In 2018, the Basel Convention had 187 parties, and 14 Basel Convention Regional and Coordinating Centres have been established for capacity building and technology transfer.

The Rotterdam Convention promotes shared responsibility and cooperation between countries in the international trade of hazardous chemicals, including banned or controlled pesticides and industrial chemicals, in order to protect human health and the environment. As of 2018, there were 161 parties to the Rotterdam Convention.

The Stockholm Convention requires parties to eliminate production of and restrict import and export of persistent organic pollutants. As of 2018, there were 182 parties to the Stockholm Convention.

The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. It was agreed at the fifth session of the Intergovernmental Negotiating Committee on mercury in Geneva, Switzerland in January 2013, and adopted later that year in October 2013 at a Diplomatic Conference (Conference of Plenipotentiaries), held in Kumamoto, Japan. As of 2018, there are 101 parties to the Minamata Convention.

References:


Notes:
The United Nations Industrial Development Organization (UNIDO) e-waste program aims to develop environmentally sound e-waste recycling industries in developing countries, promoting environmental service in local and regional e-waste facilities. To this end, UNIDO partners with private and public sector institutions and also prepares national e-waste assessment reports.

The Solving the E-waste Problem (StEP) Initiative began in 2004 as a multi-stakeholder platform with the overall aim to address global e-waste challenges. With members from industry, governments, international organizations, NGOs and academia, StEP initiates and facilitates approaches towards the sustainable handling of e-waste through a five task force design approach: (1) policy and legislation, (2) redesign, (3) reuse, (4) recycle, and (5) capacity building. The StEP Initiative is coordinated by a Secretariat hosted by the UN’s academic arm, the United Nations University.

The Sixty-third World Health Assembly, convened in 2010, approved resolution WHA63.25 Improvement of health through safe and environmentally sound waste management. This resolution urged Member States to assess health aspects of waste management and supported greater awareness, improved cooperation and increased capacity in e-waste management.

The Geneva Declaration on E-waste and Children’s Health was issued in 2013 to state that scientific information is sufficient to support a concern about the improper management of e-waste and its adverse health effects, including to vulnerable populations and not limited to occupationally exposed individuals.

In 2013 WHO launched the E-Waste and Child Health Initiative aiming at protecting children and their families from detrimental health consequences due to e-waste. UN agencies in collaboration with partners at country level are working towards improving product design, reducing consumption, establishing official e-waste collection, controlling trans-boundary movements of e-waste and implementing safe recycling of e-waste.

References:


Image:
• © WHO/SEARO
National level

• Reduce toxicity
  • Phase out specific chemicals from EEE
• Identify e-waste streams and regulate waste management and recycling
• Implement standards, actions and programmes on e-waste toxicant exposures
  • Reduce and reuse waste policies
  • “Take back” programs
  • Design maximized for durability, repairability and reusability
• Eradicate child labour within e-waste

Notes:
Examples of approaches that could be taken at a national level include:
• Reducing chemicals in EEE -- Certain chemicals have been phased out from electronic equipment (e.g., PCBs used as dielectric fluid and plastics are prohibited in OECD countries), although they still can be found in e-waste from past generation of electronic devices.
• Maximizing design -- The criteria for green design include factors such as reducing toxicity and energy use, streamlining product weight and materials and identifying opportunities for easier reuse of components and materials.

References:
Notes:
Prevention depends on local government, operators of recycling services, on community participation together with national, regional, and global initiatives.

At the formal occupational setting, it is important to invest in engineering control (dust control, cleaning methods, ventilation and air extraction, toxic solvents replacement), work practice (training, safe work practice, medical surveillance) and personal protective equipment (PPE): resistant gloves, footwear, body protection, respiratory protection (particulate and chemical gas respirator).

At the informal recycling setting, certain activities should be phased out. Local initiatives include “substitution” of hazardous practices: Agbogbloshie (Ghana), Manila (Phillipines), and remediation of adjacent recycling areas to prevent indirect exposure.

Reference:
A harm reduction approach: Examples

Substitution of hazardous practices
• Use of wire stripping machines

Notes:
Local initiatives include “substitution” of hazardous practice.

At the Agbogbloshie scrap metal site in Ghana, young workers recovered metals from e-waste by manually disassembling and burning computer wires and refrigerator coils, using old car tires as fuel for fire. Without protective equipment, workers were exposed to lead, smoke and air pollution. Nearby communities were also exposed to pollution due to these hazardous e-waste practices.

In 2014, a pilot project introduced wire stripping machines that allowed workers to remove plastic encasements from wires without burning it. A small number of machines was first piloted in order to allow workers to train and understand the benefits of using this equipment rather than burning. After the initial phase, more machines were purchased and more workers trained.

It was found that machines were effective for larger wires but less so for small ones, so that more comprehensive machines were needed. One such machine purchased later for the site was a granulator and separator, which is able to effectively chop small wires, then separate and sort metal from plastic coating. The intervention adapted to the conditions of the site as improvements became clear over time.

Reference:

Image:
• © Antonio Pascale. Wire stripping machine at the WEEE Centre in Nairobi, Kenya. Used with copyright permission.
Environmental remediation in Guiyu

Notes:
In 2011-2012, family workshop e-waste sites in Guiyu were closed and a central dismantling area was built. The environment has improved greatly since that time.

Reference:

Images:
• © Xia Huo.
Children exposed to lead from contaminated e-waste sites in Montevideo were found to have elevated blood lead levels. The Blacksmith Institute then trained the city government to assess and remediate lead-contaminated sites. This included removing contaminated soil and replacing with clean soil as pictured in the Aquiles Lanze neighborhood. Remediation of contaminated recycling areas can prevent children’s indirect exposures to e-waste.

Reference:

Images:
• © Darío Pose. Remediation of contaminated sites (“hot spots”) related to informal e-waste recycling activities. IMM – UPA – GAHP – Pure Earth Uruguay Intervention. Used with copyright permission.
Health care providers play a key role in e-waste initiatives

- Promoting interventions to prevent, reduce and mitigate exposure
- Guiding surveillance and epidemiological vigilance for related acute and chronic illness
- Working with guidelines and treatment protocols
- Educating other health care professionals
- Promoting policies for the safe management of e-waste

Image:
- © WHO/Tania Habjouqa
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