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Health-care waste management

To reduce the burden of disease, health-care waste needs sound management, including alternatives to incineration

In the last few years there has been growing controversy over the incineration of health-care waste. Under some circumstances, including when wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (PVC) are incinerated, dioxins and furans and other toxic air pollutants may be produced as emissions and/or in bottom or fly ash (ash that is carried by air and exhaust gases up the incinerator stack). Exposure to dioxins, furans and co-planar PCBs may lead to adverse health effects.

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What are dioxins, furans and co-planar PCBs?

Dioxins, furans and co-planar PCBs are toxic substances produced as by-products of various industrial processes, including the combustion of wastes containing polyvinyl chloride (e.g., some plastics, some blood bags and fluid bags). This happens particularly when wastes are incinerated at temperatures lower than 800 degrees Celsius or when the wastes are not completely incinerated. Dioxins, furans, co-planar PCBs and other toxic air pollutants may then be produced as emissions and/or in bottom or fly ash. In some circumstances dioxins and furans can be produced under natural conditions (e.g. volcanic activity and forest fires).

Polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) are called dioxins, furans and co-planar PCBs, respectively. Amongst the different dioxins and furans, not all have the same toxicity; some are even harmless. Dioxins, furans and co-planar PCBs are persistent substances that do not readily break down in the environment and that bio-accumulate in the food chain. Most human exposure to dioxins, furans and co-planar PCBs is through the intake of food.

Health concerns and intake limits

Long-term, low-level exposure of humans to dioxins and furans may lead to the impairment of the immune system, the impairment of the development of the nervous system, the endocrine system and the reproductive functions. Short-term, high-level exposure may result in skin lesions and altered liver function. Exposure of animals to dioxins has resulted in several types of cancer.

The International Agency for Research on Cancer (IARC) classifies dioxins as a "known human carcinogen". However, most of the evidence documenting the toxicity of dioxins and furans is based on studies of populations that have been exposed to high concentrations of dioxins either occupationally or through industrial accidents. There is insufficient evidence to prove that chronic low-level exposures to dioxins and furans causes cancer in humans.

WHO has established a Provisional Tolerable Monthly Intake (PTMI) for dioxins, furans, and polychlorinated biphenyls (PCBs) of 70 picograms (10^{-12} g) per kilogram of body weight. The PTMI is an estimate of the amount of chemical per month that can be ingested over a lifetime without appreciable health risk. Almost all exposure to dioxins and furans is through the food chain and the PTMI represents the cumulative exposure to dioxins and furans from all sources including food and water.

It has not yet been possible to estimate the worldwide burden of mortality and morbidity from exposure to dioxins and furans: the exposure and risk assessment has many uncertainties; data gaps are very large.

Additionally, the types of health effects that may result (e.g. cancer, impaired immune function) would only show up after long exposure periods and would be difficult to measure.

A number of countries have defined emission limits that range from 0.1 ng TEQ/m³ (Toxicity Equivalence) in Europe to 0.1 ng to 5 ng TEQ/m³ in Japan, according to incinerator capacity.

Even in high temperature incinerators (>800 °C), temperatures are not uniform and dioxins and furans can form in cooler pockets or during start-up or shut-down periods. Optimization of the incineration process can reduce the formation of these substances by, for example, ensuring that incineration takes place only at temperatures above 800°C, and that flue gas temperatures in the range of 250°C to 450°C are avoided.

In the last 10 years, stricter emission standards for dioxins and furans in many countries have significantly reduced the release of these substances into the environment. In several European countries where tight emissions restrictions were adopted in the late 1980s, dioxin and furan concentrations in many types of food (including mother's milk) have decreased sharply.

The amount of health-care waste produced can be substantial

The safe disposal of health-care waste generated at smaller rural clinics or larger facilities is feasible where adequate, well-operated infrastructure exists. However, the volume of waste generated within large facilities and during immunization campaigns may be difficult to dispose of safely when resources are limited. In 2001, during a measles mass immunization campaign in West Africa (covering all or part of six countries), 17 million children were vaccinated, resulting in the generation of nearly 300 metric tonnes of injection waste. Without adequate waste disposal options at both local and regional levels, this volume of waste would have been difficult to eliminate safely.

Incorrect disposal of health-care waste creates other health risks

The unsafe disposal of health-care waste (for example, contaminated syringes and needles) poses public health risks. Contaminated needles and syringes represent a particular threat as the failure to dispose of them safely may lead to dangerous recycling and repackaging which lead to unsafe reuse. Contaminated injection equipment may be scavenged from waste areas and dumpsites and either be reused or sold to be used again. WHO estimated that, in 2000, contaminated injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- two million hepatitis C virus (HCV) infections (40% of all new infections); and
- at least 260 000 HIV infections (5% of all new infections).

In 2002, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64%.

In addition to the public health risks, if not managed, direct reuse of contaminated injection equipment results in occupational hazards to health workers, waste handlers and scavengers. Where waste is dumped into areas without restricted access, children may come into contact with contaminated waste and play with used needles and syringes. Epidemiological studies indicate that a person who experiences one needle stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively of becoming infected with HBV, HCV and HIV.

The way forward

The management of health-care waste requires increased attention and diligence to avoid the substantial disease burden associated with poor practice, including exposure to infectious agents and toxic substances. Incinerators provide an interim solution especially for developing countries where options for waste disposal such as autoclave, shredder or microwave are limited.

Whatever the technology used, best practice must be promoted to ensure optimal operation of the system. To reduce exposure to toxic pollutants associated with the combustion process such as dioxins, furans, co-planar PCBs, nitrogen and sulphur oxides as well as particulate matter and to minimize occupational and public health risks, "best practices" for incineration must be promoted, and must include the following elements:

1. Effective waste reduction and waste segregation, ensuring that only appropriate wastes are incinerated;
2. Siting incinerators away from populated areas or areas where food is grown, thus minimizing

5. Proper operation, critical to achieving the desired combustion conditions and emissions. In summary, operation must: utilize appropriate start-up and cool-down procedures; achieve (and maintain) a minimum temperature before waste is burned; use appropriate loading/charging rates (both fuel and waste) to maintain appropriate temperatures; ensure proper disposal of ash; and ensure use of protective equipment to safeguard workers;
6. Periodic maintenance to replace or repair defective components, including inspection, spare parts inventory, record keeping, and so forth;
7. Enhanced training and management, possibly promoted by certification and inspection programmes for operators, the availability of an operating and maintenance manual, management oversight, and maintenance programmes.

Management and operational problems with incinerators, including inadequate training of operators, waste segregation problems, and poor maintenance, are recognized as critical issues that should be addressed in assessment and waste management plans.

How to address unsafe incineration

To better understand the problem of health-care waste management, WHO guidance recommends that countries conduct assessments prior to any decision as to which health-care waste-management methods be chosen. Tools are available to assist with the assessment and decision-making process so that appropriate policies lead to the choice of adapted technologies. In support of sound health-care waste management, WHO proposes to work in collaboration with countries through the following strategy:

In the short-term

- Until countries have access to proven, environmentally safe options for the management of health-care waste, incineration may still be seen as an appropriate response. Incineration should comply with the following recommendations:
 - good practices in incinerator design, construction, operation (e.g., pre-heating and not overloading the incinerator, incinerating only at temperatures above 800°C), maintenance and lowest emissions;
 - The use of waste segregation and waste minimization practices to restrict incineration to appropriate infectious wastes;
 - availability of good practices tools, including dimensional construction plans, clear operational guidelines, etc.;
 - correction of current deficiencies in operator training and management support, which lead to poor operation of incinerators;
 - materials containing chlorine such as polyvinyl chloride products (e.g., some blood bags, IV bags, IV tubes, etc.) or heavy metals such as mercury (e.g., broken thermometers) should never be incinerated.
- Research and production by manufacturers of all syringe components made of the same plastic to facilitate recycling;
- Selection of PVC-free medical devices;
- Identification and development of safe recycling options wherever possible (for plastic, glass, etc.);
- Research and promotion of new waste management technologies or alternatives to incineration;
- Promotion of the principles of environmentally sound management of health-care waste as set out in the Basel Convention.

In the mid-term

- Further efforts to eliminate unnecessary injections to reduce the amount of hazardous health-care waste that needs to be treated;
- Research into the health effects of chronic exposure to low levels of dioxin, furan and co-planar PCBs;
- Risk assessment to compare the health risks associated with first incineration and secondly exposure to health-care waste.

In the long-term

- Support of countries in the development of national guidance manuals for the sound management of health-care waste;
- Effective, scaled-up promotion of non-incineration technologies for the final disposal of health-care wastes to prevent the disease burden from (a) unsafe health-care waste management and (b) exposure to dioxins and furans;

both the disease burden from unsafe health-care waste management and potential risks from dioxins, furans and co-planar PCBs. WHO will:

- Prevent the health risks associated with exposure to health-care waste for both health workers and the public by promoting environmentally sound management policies for health-care waste;
- Support global efforts to reduce the amount of noxious emissions released into the atmosphere to reduce disease and defer the onset of global climate change;
- Support the Stockholm convention on Persistent Organic Pollutants (POPs);
- Support the Basel Convention (1989) on hazardous wastes and other wastes;
- Reduce the exposure to toxic pollutants associated with the combustion process through the promotion of appropriate practices for high temperature incineration.

RELATED LINKS

- [Health-care waste management web site](#)
- [Medical waste](#)

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