

Effects of improper hospital-waste management on occupational health and safety

S. V. Manyele
TANZANIA

Introduction

The improper management of medical waste causes serious environmental problems in terms of air, water and land pollution. The nature of pollutants can be classified as biological, chemical and radioactive. Environment problems can arise from the mere generation of medical waste and from the process of handling, treatment and disposal. This paper analyses the effects of improper medical waste management and recommends proper means for safeguarding health care workers.

Mismanagement of hospital waste implies a combination of improper handling of waste during generation, collection, storage, transport and treatment. Improper handling comprises several unsafe actions, such as handling without personal protective equipment (PPE), poor storage (e.g. high temperature conditions combined with prolonged storage times before treatment), manual transport for longer distances, use of uncovered containers instead of closed plastic bags, etc. Other examples include exposure times beyond acceptable limits, lack of worker and equipment decontamination procedures, etc., all of which affect hospital workers in different ways.

In Tanzania, hospital waste was largely mismanaged in the past, mainly because the sector did not know what to do with the waste. The procedures for safe waste handling were not adhered to; for example, there were deficiencies in designation and identification of infectious waste, segregation, packaging and storage, as well as in transport procedures. Following countrywide training of incinerator operators and health officers in 2003, the management of hospital waste is now taking a new shape. However, treatment techniques

for hospital waste are still poor. There are neither proper methods of treated waste disposal nor written contingency plans.

Safeguarding the health care workforce against occupational health risks arising from hospital-waste management calls for effective infectious waste control measures. In addition to protecting workers' health, such control measures protect public health and the environment from the hazards posed by hospital waste. Proper management ensures that infectious waste is handled in accordance with established and acceptable procedures from the time of generation through treatment of the waste and its ultimate disposal.

The first issue is to define what is meant by hospital waste. The terms 'hospital waste', 'medical waste', 'regulated medical waste', and 'infectious waste' remain poorly defined in the literature (1). No standard, universally accepted definition for these terms exists, and many definitions are in use by practitioners and regulators. Given the diversity of interest and scientific credentials of persons, groups, and agencies (e.g. physicians, health departments, hospitals, environmentalists, trade unions, and state legislators) involved in the medical waste issue, these differences should be expected. However, adoption of a definition by a regulatory agency has serious ramifications because it dictates all the terms.

'Hospital waste' (or solid waste) refers to all waste, biological or non-biological, that is discarded and not intended for further use. 'Medical waste' refers to materials generated as a result of patient diagnosis, treatment, or the immunization of human beings or animals. 'Infectious waste' refers to the portion of medical waste that could transmit an infectious disease (2). Thus, 'medical

waste' is a subset of 'hospital waste', and 'regulated medical waste', which is synonymous with 'infectious waste' from a regulatory perspective, is a subset of 'medical waste'.

As stated, infectious waste is waste that is capable of producing an infectious disease; chances of this are higher within hospitals than outside (2, 3, 4). This definition requires consideration of the factors necessary for induction of disease, which include dose, host susceptibility, the presence of a pathogen, the virulence of a pathogen, and the most commonly absent factor, a portal of entry (2). Therefore, for waste to be infectious, it must contain pathogens with sufficient virulence and quantity so that exposure to the waste by a susceptible host could result in an infectious disease.

Other health care settings, such as dental offices and nursing homes, present work environments similarly complicated as those in hospitals, where workers face a variety of occupational hazards. The hazards can be classified in the following categories: biological or infectious hazards (bacteria, such as tuberculosis, and viruses, such as HIV, hepatitis B and hepatitis C, which can be transmitted by contact with infected patients or contaminated body secretions/fluids); chemical hazards (medications, solutions, or gases, such as ethylene oxide, formaldehyde, glutaraldehyde, waste anaesthetic gases, nitrous oxide, chemotherapeutic agents, laser smoke and aerosolized medications such as Pentamidine); and physical hazards (ionizing radiation, lasers, noise and electricity).

Exposure routes for hospital waste

The occupational health effects of medical and other hazardous wastes depend

on the duration of exposure and the dose of toxic components that enters the worker's body from the waste. Unmanaged hospital waste constitutes a hazard to the personnel because it contains toxic chemicals and pathogens ready to enter the human body through different routes of exposure (4).

The routes of health care workers' exposure to hazardous substances contained in hospital waste include ingestion (swallowed material), inhalation (airborne chemicals and pathogens), and dermal absorption or through skin openings (3, 4). Due to the structure of the human lung, the body's retention capacity for airborne particulates that carry toxic chemicals and pathogens is highly dependent on particle size. Dermal absorption can be enhanced by scratched, broken, roughened or abraded surfaces of the skin on the ankles, hands, neck or facial areas. The worker's face or hands are the most affected skin areas. Water-soluble toxic chemicals can be absorbed throughout the body since the human metabolism operates on a water-based chemistry. Drinking and eating in hospitals must be done in well-controlled areas. This issue is not well managed in most Tanzanian hospitals and health centres.

The chemical poisons in hospital waste can affect different parts of the body: for instance, hepatotoxic agents (e.g. carbon tetrachloride, tetrachloroethane) affect the liver; nephrotoxic agents (e.g. halogenated hydrocarbons) affect the kidneys; haematopoietic toxins (benzene, phenols) affect blood; and neurotoxic agents (e.g. methanol, metals, organometallics) and anaesthetic agents (e.g. ethyl ether, esters, acetylene hydrocarbons) affect nerve systems and consciousness, respectively (4).

Occupational health hazards from improper medical waste management

Pathogens present in waste can enter, and remain in the air within the hospital for a long period, in the form of spores or as pathogens themselves (5). This can result in hospital-acquired infections (nosocomial infections) or occupational health hazards. Patients and their attendants also have a chance of contracting infections caused by airborne pathogens or spores. However, there are very limited statistics available relating occupational health with workers' hospital-acquired infections. This topic requires more research. The only publicized health hazard to workers is the spread of disease from contaminated



Photo by ILO / M. Crozet

Mismanagement of hospital waste implies a combination of improper handling of waste during generation, collection, storage, transport and treatment. (People in the photo are not related to this article).

sharps (medical equipment used to penetrate skin and muscles like needles, blades, etc.) (2). When waste that has not been pretreated is being transported outside the hospital, or dumped openly, pathogens can enter the atmosphere. These pathogens can find their way to drinking water, foodstuffs, soil, etc., or they can remain in the ambient air.

Chemical pollutants that cause outdoor air pollution have two major sources: open burning and incinerators. The presence of plastics and hazardous materials in the waste will generate harmful gases – such as oxides of sulphur, oxides of nitrogen, carbon dioxide, etc. – and suspended particulate matter which may contain heavy metals. These when inhaled can cause respiratory diseases. Certain organic gases, such as dioxins and furans, are carcinogenic whose effects have longer latency periods. Open burning of medical waste is practised in many Tanzanian hospitals. This should be strictly avoided. Air pollution control devices should be used for waste combustion technologies which produce toxic emissions. Such units exist now in Tanzania, designed at the University of Dar es Salaam.

Research and radio-immunoassay activities may generate small quantities of radioactive gas. The clinical application of ^{85}Kr and ^{133}Xe is the principal source of gaseous radioactive waste material requiring special disposal practices (1, 5). Gaseous radioactive material should be evacuated directly to the outside. For the workers' safety, such gaseous radioactive waste should not be mixed with the indoor air. If a special

exhaust system is not available, an activated carbon trapping device may be used, which requires maintenance of the trap and monitoring of the off-gas; this, in turn, is a question of workers' exposure (1, 5).

Indoor air pollution due to biological agents can be reduced by covering the waste properly, routing the waste so that the shortest distance is used and sensitive areas are avoided. Segregation of waste, pretreatment at the source, etc., can also reduce this problem to a great extent. Sterilizing the rooms will also help to minimize the occupational health risks posed by air pollutants from biological agents. Indoor air pollution can also result from poor ventilation; thus the building design plays an important role in maintaining proper ventilation.

The health hazards due to improper waste management affect not only hospital occupants; they can also spread in the vicinity of a hospital. Occupational health concerns exist for janitorial and laundry workers, nurses, emergency medical personnel, and waste handlers. Injuries from sharps and exposure to harmful chemical waste and radioactive waste can also pose health hazards to workers. The problem of occupational health hazards arising from medical waste is not well publicized as there is a lack of information.

The general public's health can also be adversely affected by medical waste. Improper practices, such as dumping of medical waste in municipal dustbins, open spaces, water bodies, etc., can lead to the spread of diseases. Emissions from incinerators and open burning can

also lead to workers' exposure to harmful gases which can cause cancer and respiratory diseases. Exposure to radioactive waste in the waste stream can also pose serious health hazards to workers. An often ignored area is the increase of home-based health care activities. During the training sessions conducted countrywide in 2003, this topic was addressed as 'home-based health care waste management'. An increase in the number of diabetics who inject themselves with insulin, home nurses taking care of terminally ill patients etc., all generate medical waste which can cause health hazards.

Recommendations

Observing exposure limits

With respect to a wide variety of contaminants related to management of hospital waste, certain exposure levels are allowed by law. The most well-known of allowable exposure standards are the threshold limit values (TLVs), which are normally expressed at two levels: the time-weighted average (TWA) based on an eight-hour allowable average concentration, and the short-term exposure levels (STEL), based on the maximum 15-minute average concentration to which a health care worker may be exposed. Currently, TWA and STEL have been adopted as permissible exposure levels (Peels), and are now legally enforceable levels of exposure in countries where environmental laws are in place. If such limits are observed, the occupational health problems can be minimized in hospitals (4).

Apply a hierarchy of controls

Health care workers' exposure to health hazards can be prevented or reduced. The occupational hygiene hierarchy of controls is a recognized method for primary prevention of occupational injury and disease. The following hierarchy is listed in order from the most to the least effective: elimination of hazardous materials and dangerous activities; substitution of less hazardous materials (e.g. substitute oxidizing chemicals such as paracetic acid for glutaraldehyde, nitrile gloves for latex or vinyl gloves); engineering controls (e.g. lifting devices, safer needle devices, ventilation); administrative controls (such as policies that limit workers' exposure to hazards); and appropriate allocation of personal protective equipment (e.g. gloves, respirators and masks, goggles, gowns, etc.).

Enforcement of medical waste management regulations

There must be clearly stipulated rules that apply to all persons who generate, collect, receive, store, transport, treat, dispose of, or handle medical waste in any form. This will help to maintain occupational and public health. Those who generate medical waste must be legally responsible. It shall be the duty of every generator of medical waste (which includes a hospital, nursing home, clinic, dispensary, veterinary hospital, animal house, pathological laboratory, blood bank) to take all steps to ensure that such waste is handled without any adverse effect to workers and the environment (6, 7).

Medical waste shall not be mixed with other wastes, and shall be segregated into well-labelled containers or bags at the point of generation prior to its storage, transport, treatment and disposal. Apart from the prescribed label, transit containers containing medical waste shall also bear information on the date of generation, the waste category/class/description, the sender's/receiver's name and address (phone/fax numbers) and the contact person in case of emergency. The label shall also be marked with symbols, such as the universal bio-hazard or cytotoxic hazard symbol, and warning signs, e.g. "handle with care" (7).

Untreated medical waste shall be transported only in a special vehicle owned by a competent authority, as specified by the government. No untreated medical waste shall be kept or stored beyond a period of 48 hours. The municipal body of the area shall continue to pick up and transport segregated non-medical solid waste generated in hospitals and nursing health centres, as well as duly treated medical wastes for disposal at a municipal dump site.

Every generator/occupier/operator shall submit a report to the prescribed authority every year, to include information about the categories and quantities of medical wastes handled during the preceding year. The prescribed authority shall compile this information for future reference. Meanwhile, every authorized person shall maintain records related to the generation, collection, reception, storage, transport, treatment, disposal and/or any form of handling of medical waste, in accordance with these rules and any guidelines issued. All records shall be subject to inspection and verification by the prescribed authority at any time (7).

Promote training in hospital-waste management

Training of health care workers is the core of health care waste management programmes (8). The sessions conducted by the Ministry of Health in 2003 enabled workers to recognize health and safety hazards, and to prevent further exposure to hazards posed by hospital waste. In reality, health care worker training programmes have increased the workers' morale. However, the training focused only on those handling hospital waste and health officers, while the waste generators (nurses and medical doctors) were not involved. For this reason, a comprehensive integrated health and safety training programme has been developed at the University of Dar es Salaam to provide a cost-effective means of meeting health care waste management needs in Tanzania.

Hospital-waste handling is a hazardous waste activity which requires a high standard of training. It calls for specific training that depends on the nature of the work in the hospital, the hazards and possibility of worker exposure, and the responsibilities of individual workers (8). The training must not only be continuous, but also comprehensive, integrated and structured with the necessary elements.

To reach the qualified stage, the training must follow some of the following steps: need analysis; training administration; learning objectives development and lesson plans; site-specific training; task-specific training; and supervision. As hospital activities are similar, these steps will be almost the same for different hospitals, so that the training sessions can be conducted for each worker categories. Factors to consider include trainers' qualification, reciprocity (e.g. the Ministry of Health's acceptance of course work offered by the University of Dar es Salaam), equivalency (determination that previous experience, education or training is equivalent to a given training course), and programme evaluation (monitoring and revision of the training as a result of the comments received from participants, instructors and supervisors) (8).

Environmentally preferable purchasing

Environmentally preferable purchasing (EPP) is the act of purchasing products and services that are less damaging to occupational health and the environment. Efforts to implement EPP are an important component of a larger system that supports the integrity of both business and environmental decisions, for

the benefit of workers' health (9).

Five areas have been identified as focal points for EPP (9). They include: products containing mercury; products containing polyvinyl chloride (PVC); reprocessed and reusable products; green building products; and safer products for workers. In addition, waste minimization practices implemented by purchasing products with reduced packaging and the procurement of items that are readily recyclable and/or made of recycled content are highly recommended.

Proper worker and equipment decontamination

Anything that enters a hazardous waste exclusion zone (radiological area, or airborne radioactivity area) is assumed to be contaminated. If not removed, contaminants eventually penetrate the PPE, tools, instruments, and other equipment in use at the worksite, and may be transferred into clean areas (1). Improper management occurs when such items are not decontaminated (i.e. removing or neutralizing chemicals, radiological, biological or mixed waste contaminants) and hazardous material accumulates on personnel and equipment while work is being performed (1,8).

Factors affecting contaminant permeation of PPE and other equipment include contact time, concentration, temperature, chemical characteristics, and the physical state of the contaminants. Decontamination by physical means can be used for loose contaminants (dusts, aerosols), adhering contaminants, adsorbed or permeated contaminants or volatile contaminants. Decontamination using solutions, chemicals or other materials must follow physical decontamination. Decontamination materials can also be applied directly to chemical or radiological contaminants. Cleaning solutions can involve one or more of the following methods: dissolving contaminants; surfactants; solidification; rinsing; or disinfection/sterilization. It must be stressed that decontaminations differ from sanitation in that the former is conducted either in the contamination reduction zone or radiological buffer zone at the worksite, whereas sanitation functions are performed either in the support zone or outside the boundaries of the hazardous waste activities worksite after decontamination has been completed (1,8).

For this reason, the time required for decontamination must be incorporated in work plans and schedules. By contrast, contamination control and decontamination strategies and procedures

must be well documented in the hospital's health and safety plan (HASP), communicated to workers and implemented before workers enter hazardous areas.

Medical surveillance programmes for health care workers

Medical surveillance programmes must be designed to accomplish the following goals: to demonstrate that workers are fit to perform their jobs safely and reliably; to provide ongoing assurance that access and hazard controls limit worker exposure; and to comply with occupational health regulations. A comprehensive medical surveillance programme should be designed and implemented by an experienced and qualified occupational health physician or examiner with inputs provided by workers, industrial hygienist, as well as health and safety professionals. Based on the presence of such hazards as lead, asbestos, and carcinogens, special types of medical surveillance are required. The occupational health physician responsible for the medical surveillance programme should work with the rest of the medical surveillance team to determine which forms of surveillance are applicable for activities at each worksite (1,8).

Analysis of surveillance data should include at least the following elements on each infection, in order to detect clusters and trends: type of infection; date of onset; location in the facility; and appropriate culture information. Infection rates should be calculated periodically, recorded, analysed, and reported to the administration and the infections control committee. Tables, graphs, and charts may be used, to facilitate education of the personnel. Surveillance data should be used for planning infection control efforts, detecting epidemics, directing continuing education, and identifying individual resident problems for intervention (8).

References

1. Blackman WC. "Basic Hazardous Waste Management", Lewis Publishers, Inc., Michigan, USA, 2nd Edition, 1996.
2. Rutala WA, Mayhall CG. "Medical Waste", in Infectious Control and Hospital Epidemiology, vol. 13(1), January 1992, pp. 38-48.
3. Manyele SV. "Medical/hazardous Waste Management for Practitioners", Course notes for the BICO Professional Development Program, Prospective College of Engineering and Technology, University of Dar es Salaam, January 2004.
4. Griffin RD. "Principles of Hazardous Materials Management", Lewis Publishers, Inc., Michigan, USA, 1990.
5. <http://kspcb.kar.nic.in/BMW/>

[environmental.htm](http://www.environmental.htm)

6. <http://kspcb.kar.nic.in/BMW/Laws.htm>
7. US Federal Register, US – Environmental Protection Agency, 40 CFR Part 60, Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Medical Waste Incinerators; Proposed Rule, February, 1995.
8. Handbook for Occupational Health and Safety During Hazardous Waste Activities, Office of Environmental Management, US Department of Energy, June, 1996.
9. http://www.cehca.org/SHEA6_Occup_Safety.pdf

Dr. Samwel V. Manyele
Waste Management Research
Department of Chemical &
Process Engineering
University of Dar es Salaam
P.O. Box 35131
Dar es Salaam, Tanzania
smanyele@cpe.udsm.ac.tz

CCOHS has released a new web design of Occupational Health and Safety Encyclopaedia

The Canadian Centre for Occupational Health and Safety (CCOHS) has released a new design of the web version of the ILO Encyclopaedia of Occupational Health and Safety. Users can search the ILO Encyclopaedia on its own, or together with the CIS-ILO database.

The Fourth Edition of the Encyclopaedia of Occupational Health and Safety, published by the International Labour Office of the United Nations, consists of more than 100 chapters with over 1,000 separate articles containing essential safety information gathered by health and safety experts around the world. Its comprehensive coverage of occupational health and safety topics will assist anyone concerned about these issues, including non-specialists such as lawyers, physicians, nurses, engineers, as well as occupational hygienists, toxicologists, regulators and other safety professionals.

For more information or to subscribe to the web version of the Fourth Edition of the ILO Encyclopaedia of Occupational Health and Safety, **contact CCOHS' Client Services at clientservices@ccohs.ca**

or

visit us on the web at the address <http://www.ccohs.ca>