Forum: Environment Commission

Issue: Promoting the safe disposal of medical waste and harmful chemicals

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Introduction

Healthcare activities are very important in restoring global health and save lives, especially in times of COVID-19. However, has anyone wondered about the wastes produced from such maintenance of healthcare generates?

It is estimated that the US individually produces around 5.9 million tons of healthcare medical waste each year. Of all the wastes generated by healthcare activities, a majority (85%) are general, non-hazardous wastes that can be treated equally as domestic wastes. The remaining are hazardous wastes, which is the focal point of this report as they are infectious, chemical, or radioactive that will in turn have adverse health effects on humans if not properly disposed of ("Health-care waste").

The sources of hazardous wastes come from the human excretion of patients in hospitals, chemical wastes present in equipment or used for diagnosis of patients, the need for constantly maintaining a sterilized environment in the hospital, and lastly, expired drugs. Currently, in more developed countries (MEDCs) there are multiple methods of disposal that are affordable and used, including mechanical processing, chemical treatment, and thermal treatment. These methods are generally more environmentally friendly. However, less developed countries (LEDCs) are forced to turn to traditional incineration methods due to economic budget. Other factors that limit the proper disposal of healthcare wastes in LEDCs also include a lack of land and law regulations. Since infectious diseases are most prevalent in LEDCs, efforts in saving lives in combination with improper disposal of health-care wastes will only aggravate the spread of deadly diseases. Hence, it is critically important to set up systematic ways of disposing medical wastes, to create a world of healthcare without harm.

Definition of Key Terms

Healthcare waste (HCW or Medical waste)

Medical waste is a broad term used to describe any type of wastes generated in the process of diagnosis, dialysis, treatment, or research of human diseases ("Healthcare waste"). Medical wastes come in different forms (solids, semi-solids, liquids, and powders) and different types. This report

focuses on hazardous wastes that come from health care facilities and research laboratories that constitute medical wastes.

Hazardous waste

Any waste that contains potential threats to the environment or public health. It includes infectious, pathological, sharps, pharmaceutical, cytotoxic, radioactive, and harmful chemical wastes. Some hazardous waste can be characteristic, meaning they exhibit one of the following traits: ignitability, reactivity, corrosivity, or toxicity.

Infectious waste

Single-use items that have been in contact with patients with infectious diseases. This includes any diagnostic items and disposable medical devices used by hospitals. Therefore, they are suspected to contain pathogens, which are microorganisms that cause diseases in the human body.

Pathological waste

A form of infectious waste that pertains to the bodily parts of a patient (e.g. blood and tissues), often disposed by medical, research, or school institutes.

Sharps waste

Items that contain an edge point, strong enough to puncture wounds or cuts. Some examples are needles, syringes, disposable blades, and even broken glasses. Sharps wastes are considered as a highly hazardous waste, even when uninfected by pathogens.

Pharmaceutical waste

Any expired and unused drugs. There are different listings of hazardous pharmaceuticals (F, K, P, U, or PCD) to categorize different effects it has on the environment.

Genotoxic waste

Drugs that have mutagenic, carcinogenic, and teratogenic properties ("2: Definition" [4]). A subset of it is cytotoxic (often antineoplastic) drugs, that are toxic to living cells. Cytotoxic drug wastes are often produced by oncology and radioactive units of hospitals, with its drugs mainly used for cancer treatment. However, genotoxic waste properties may also be present in urine, feces, and vomit from patients that have been treated with cytotoxic drugs. Such wastes are considered cytotoxic waste in between 48 hours to 1 week after drug administration ("2: Definition" [5]).

Radioactive waste

Waste that contains radioactive material, with a genotoxic effect on organisms by penetrating through their skin.

Chemical waste

Wastes that contain chemical substances. Hazardous chemical wastes after often produced due to daily maintenance of hospitals like sterilization, photographic X-ray, chemotherapy, just to list a few. Such wastes are hazardous due to their toxic, corrosive, flammable, reactive, and genotoxic properties

("2: Definition" [5]). This category also includes wastes with a high content of heavy metals that are present in clinical equipment (e.g. mercury in thermometers).

Incineration

A method of disposing HCW products by combusting organic substances in organic substances in wastes and converting it into ash and gas.

Background Information

In order to consider solutions to the proper disposal of HCW, it is important to comprehend the sources of HCW, how it has affected humans and the environment, and the problematic aspects of current disposal methods.

Sources of HCW

Human excretion

The feces and urine hospital patients produce are considered as hazardous HCW because it can potentially contain infectious, radioactive, and genotoxic wastes.

Firstly, the constant use of antibiotics poses a selective pressure on bacteria, leading to the development of antiseptic resistance bacteria. The bacteria that obtained resistance to drugs can be released out of the human body through excretion of waste. A bad HCW disposal system, releasing feces to the environment introduces such mutated plasmids to indigenous bacteria. These developed bacteria may in turn harm wildlife and life stocks and can eventually travel up the food chain and causing an increase in antibiotic resistance issues in the human population.

Secondly, radionuclides (alpha, beta particles, and gamma rays) that are used in hospitals for research, in-vitro diagnosis, diagnosis imaging, or therapy may remain in the patients' body, with radioactive feces excreted and released into the environment. Radioactive wastes are dangerous because the energy radiation contains is enough to cause destruction to the organ systems and develop cancer. Beta and gamma rays contain penetrative effects to the skin, so improper disposal will lead to negative biological effects like mutations and cancerous growth. Less destructive radiation like alpha radiation is dangerous when enters the body through inhalation, ingestion, or wounds on the skin as it will damage living cells and tissue.

Thirdly, studies found that there is an increase in "urinary levels of mutagenic compounds in exposed workers and an increased risk of abortion" in medical workers responsible for handling antineoplastic drugs ("3. Health"). Personnel who are responsible for handling excretion in hospitals are often less aware of the risks (in comparison to doctors and nurses), therefore took little to no measures in protecting their health (Kumar et al. [412]).

Chemical wastes

Chemical wastes are often disposed by draining the liquids down the sink. However, studies have found that many "metabolites and substrates that were passed into the public sewage were capable of causing various mutagenic and genotoxic effects on the aquatic organisms". (Kumar et al. [411]) The wide variety of chemicals aggravates the situation with further reactions, mutations and poisoning aquatic organisms and other marine wildlife. This poses local water sources for crops at risk of contamination, which the consumption of these waters due to soil pollution may halt the growth of crops, leading to potential food shortages. Furthermore, chemicals are often used in medical equipment. Mercury, for example, is a highly toxic heavy metal that is often used in medical equipment. "A variety of studies demonstrate that mercury-containing health-care equipment will invariably break", therefore will have to be disposed of ("Mercury in Healthcare" [2]). The accidental release of mercury to hospital settings should be properly disposed as mercury can be corrosive to body surfaces, and fatal when inhaled or absorbed through the skin, causing damage to the organs (Chartier et al. [28]).

Bodily fluids

Bodily fluids are considered as infectious wastes, and they are critical to individuals' health, because improper disposal may enter the human body through cuts in the skin, penetration through mucous membranes, ingestion, or inhalation. Pathogens may transmit through bodily products including blood, feces, vomit, saliva, and any other bodily fluid secretions. There are concerns for the transmission of HIV through blood contact or breast milk (for nursing neonate) among healthcare workers when there is a puncture in the skin. To make the matters worse, research shows that HIV can remain dormant in human hosts for years (latent infection), while there is a possibility of the virus being transmitted to other hosts ("A timeline"). Therefore, surgeons that are in stages of latent infection have high chances of transmitting HIV to their patients.

Maintaining a sterilized environment

A universal requirement to keep hospital areas and equipment sterile are essential in preventing the spread of diseases. To fulfill such requirements, many hospitals include single-use medical items and disinfects as part of their daily maintenance.

Sharp wastes are highly hazardous as they create higher chances of infectious by creating a physical wound. Using syringes as an example, there are two types: disposable and sterilizable (meaning reusable) syringe. There are advantages and disadvantages to both. Disposable syringes are convenient and require less time as sterilization is not needed. However, unsafe disposal will result in a risk of injury (by the sharps), or even create chances of accidental reuse of sharps. Most importantly, the existence of disposable syringes has led to the rise of black markets, with news reported around the world highlighting the issue of disposed syringes being re-collected

and sold to scratch dealers ("Sterilizable syringes"). Sterilizable syringes are commonly used in poorer countries where shortages are an issue. Benefits include that it is more cost-effective, and that fewer plastics are being released to the environment. The downside is that completing disinfecting reusable syringes requires adequate training, or inadequate sterilization may be present, exacerbating the transmission of diseases. Moreover, dealing with sharps waste every day increases healthcare worker's chances of being infected.

Expired drugs

Over prescription and oversampling of drugs is a major issue in many countries. Statistics show that up to 10 billion dollars of pharmaceutical products are thrown away due to expiry (Blake). In hospitals, patients that have chronic issues often have their medications prescribed beforehand, enough for the incoming months or even years. However, if the patient has left their medication due to reasons like death, the intact drugs are thrown away. In addition, the oversampling of drugs is often left in pharmaceutical offices to be thrown away when it expires (*How Can Pharma* [00:04:47]).

Improper disposal by the general public, may involve throwing them into the bin, which will be later incinerated, releasing toxic chemicals into the air. It is important for unused drugs to be properly disposed, to prevent others (of whom the drug is unintended) inappropriately consume or abuse the expired drugs.

Waste treatment technologies

Mechanical processing

Mechanical processing involves the breaking down of bulk volume of solid waste to smaller pieces through granulating, shredding, and grinding. This is the first step of proper disposal, to increase the surface area of HCW so that they can come into contact with disinfectant and heat in latter processes to be disinfected. Mechanical processing is often performed in a closed environment as dust can be generated in the process of grinding solid wastes ("Treatment technologies").

Chemical disinfection

This process commonly occurs after mechanical processing. Disinfecting chemicals like chlorine bleach is added into wastes to kill or inactive any infectious pathogens in HCW. "The Environmental Protection Agency (EPA) identifies chemical disinfection as the most appropriate method to treat liquid medical waste" (blood, urine, hospital sewage), and even solid wastes if they are being mechanical processed ("Treatment technologies"). Even though this is a rather environmental protective option, it is limited in many industrialized and developing countries ("8: Treatment and disposal [94]). Furthermore, this method also leads to the question of other environmental issues like antiseptic resistance of bacteria, with different disinfects that are "effective in killing or inactivating specific types of microorganisms and others are effective against all types" ("8:

Treatment and disposal [95]). Therefore, relevant scientific knowledge is required in preventing corrosive hazards and related issues with bacterial resistance.

Thermal treatment

Thermal treatment involves the disinfecting of HCW using high temperature and high pressure. Wet thermal disinfection can be achieved by steam in a closed environment. This can be accomplished by an autoclave or pressure cooker in an indoor environment in hospital settings, which can guarantee up to 99.99% inactivation of microorganisms under correct operational conditions. ("8: Treatment and disposal [96]). Dry thermal treatment involves the use of microwave irradiation instead. The downside to thermal treatment is that the minimum time, temperature, and humidity varies depending on multiple factors such as “the moisture content of the waste and ease of penetration of the steam” ("8: Treatment and disposal [103]). Therefore, complete disinfection may not occur if optimum conditions are not reached for the targeting waste.

Radioactive wastes

Some wastes like radioactive wastes can only be stored properly, rather than being cleared out. Radioactive HCW often isolated using a lead box. The lead box functions to absorb alpha and beta radiation, and also attenuates gamma radiation. Otherwise, radioactive HCW can be placed in geologic locations that are far from human resides, so they are isolated from human living environments. Concerns with the geologic technique include the leakage of radioactive waste into the environment during geologic changes (e.g. earthquake). “Even very low leakage or migration of nuclear waste may result in a huge disaster because the half-lives of the [radioactive] waste are so long”. Therefore, scientists are still in search of better methods of disposal.

Inappropriate methods of disposal

Incineration

Incineration is the most commonly used method of disposal in healthcare institutes. It is generally effective in reducing landfills of HCW, but at the same time creates other health and environmental hazards (“8: Treatment and disposal”). There are different types of incinerators dedicated to the disposal of different HCW (Refer to Appendix B for more details). If certain types of wastes are combusted with the wrong temperature or the wrong method of incinerating, this may lead to environmental pollution. For instance, the incineration of HCW at a lower temperature (less than 800 °C) enables toxic airborne pollutants to form and released into the environment (“Medical waste”). The recent phenomenon of global warming, acidification, increase incidences of cancer, respiratory symptoms, congenital abnormalities, and hormonal defect are all possible effects of burning HCW (Manzoor and Sharma).

Genotoxic and radioactive wastes are generally not suitable for incineration. Mercury, for example, is often disposed through incineration, contributing to 10% of gaseous mercury releases, which

may in turn affect the general public through inhalation. Some long-term consequences include the depletion of the ozone layer in the atmosphere, which may potentially lead to climate change.

It is important to note that not all methods of incineration are unsafe methods of disposal. Novel technologies like hydroclaves and plasma pyrolysis have been developed to "decrease environmental degradation, negligible health impacts, safe handling of treated wastes, decreased running and maintenance costs, more effective reduction of microorganisms, and safer disposal" (Manzoor and Sharma).

Land disposal

According to the WHO, land disposal is an acceptable method only when other methods are unavailable, as "allowing health-care waste to accumulate at hospitals or elsewhere constitutes a far higher risk of the transmission of infection than careful disposal in a municipal landfill" ("8: Treatment and disposal" [106]). In developing countries, burial and dumping of wastes into lands and water bodies is a common phenomenon. This poses an immediate impact on the environment with soil and water pollution, increase risks of fires, and disease transmission. Therefore, unless compelled, such method of disposal is not encouraged.

Discharge of raw sewage

Discharging pharmaceutical waste down the sewage without neutralizing the chemical compounds may lead to pollution in the ecosystem and water. With regards, to antibiotic-resistant bacteria, research shows that "hospital sewage contains 2 to 10 times more antibiotic-resistant bacteria than domestic wastewater, a phenomenon which contributes to the emergence and propagation of pathogens such as MRSA (methicillin-resistant Staphylococcus aureus) ("Medical waste" [26]).

Major Countries and Organizations Involved

It is important to note that proper disposal of HCW is a worldwide issue. The countries mentioned in this section are the ones that have the most alarming amounts of disposal. It doesn't mean that the issue is only related to them.

World Health Organization (WHO)

The World Health Organization (WHO), established in 1948, plays a role in coordinating health internationally within the UN system. Over the years, WHO has not expanded to focus on other medical areas outside of communicable diseases, including the production and disposal of pharmaceutical products. A branch of the WHO, the Department of Public Health, Environmental and Social Determinants of Health (PHE) is involved with programs and activities that are focusing on the promotion of safer management of toxic substances in the home and workplace ("Department of Public"). The WHO has also

published many guidelines (like the Safe management of wastes from health-care activities) and policy documents in supporting individual member states in proper disposal of HCW.

United States of America (US)

The United States of America (US), as one of the developed countries, is the leading country in investing in healthcare, spending approximately 18% of its GDP (Shrank et al). Studies also show that overtreatment and over-prescription is a phenomenon in the US, hence releases a vast amount of unused HCW into the environment. An upside is the prevalence of medical waste disposal companies in the country, which is gradually promoting the safe disposal of HCW. In addition, many hospitals are now focusing on recycling and donating leftover medicines or medical items, to aid with the supply of essential medicines in developing countries ("Medical Waste").

India

It is estimated that India currently generates up to 775.5 tonnes of medical waste daily. Yet, the disposal system in India has difficulty in keeping up with such amounts of HCW generated. The Biomedical Waste Management and Handling Rules were passed by the Indian government in 1998. Despite the legislation, many HCW are dumped in the open area due to its small waste handling capacity, under-reporting of generated HCW, operation of healthcare facility without authorization of the legislation, and lack of awareness among related staff and the general public ("India to generate"). It is extremely common for hospitals to shut down in India due to the violation of waste disposal regulations ("Medical Waste"). Hence, the safe disposal of HCW remains as a big issue in India to date.

LEDCs in Africa

There are inadequate resources, funding, and national regulations in Africa, therefore it is difficult for them to make HCW management and disposal a priority. However, it is extremely important especially in Africa as it is home to some of the deadliest diseases like Malaria and HIV. With that said, proper disposal of sharps and should be highlighted to prevent further contamination. Yet, the safety boxes used to store sharps are unaffordable in Africa ("Medical Waste"). As a result, people turn to the most direct waste disposal method, to pile it in the landfill or to incinerate it. It has been found that "Gambia, Ghana, Lesotho, Nigeria, Senegal, Tanzania have no sanitary landfills; while Kenya and Zambia only have crude dumpsites" ("Medical Waste"). In addition, more than 1000 incinerators in Africa are found to be inoperative or did not reach the minimum operating standards.

Timeline of Events

Date	Description of event
1987 – 1988	The syringe tide, an environmental disaster during which medical waste and garbage were pushed ashore by the tide, took place in New Jersey and New York, USA.

1988	The US government passed The Medical Waste Tracking Act to stipulate rules for medical waste management in parts of the nation.
1990	The UK passed the Environmental Protection Act 1990.
1991	States in the US started to stress the importance of waste disposal as many passed laws to strictly regulate such measures.
1994	The UK passed the Waste Management Licensing Regulations 1994, dictating that entities or firms should be licensed to manage or dispose of waste.
1998	India passed the Bio-medical Waste Rules to manage the disposal of such waste systematically.
2003	Basal Convention on the Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes
2008	National Environmental Management: Waste Act 59 of 2008 is passed, to address the licensing process for medical waste producing activities in Africa.
2020	India employed over 200 licensed facilities that exclusively treat biomedical waste in a professional manner across the country.

Relevant UN Treaties and Events

- Safe management of wastes from health-care activities (2nd edition), a handbook published by the WHO in 2014 after extensive international consultation and collaboration.
- Basal Convention on the Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes, 2003.
- Report of the Special Rapporteur on the adverse effects of the movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights (A/HRC/18/31), July 4th, 2011. Refer to Appendix 4 for more details.

Previous Attempts to solve the Issue by the UN

- Basel Convention on the Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes, 2003.
    - The technical guidelines by the Basel Convention are mean to assist individual nations in building their capacity to manage HCW in an environmentally friendly matter, finding an efficient way in developing detailed procedures, plans, and strategies for HCW management. Currently, the US, EU countries, Japan, and South Korea are signatories of this Basal Convention, thereby showing its gradual effect especially on developed countries ("International Experience").

- Compendium of Technologies for Treatment/Destruction of Healthcare Waste, 2012.
    - The purpose of the compendium is to provide guidance to national and local governments, health organizations, and countries in selecting technologies suitable for economic ability for the proper disposal of HCW. "The compendium provides a robust methodology for analyzing local healthcare waste generation, composition, and disposal needs and selecting appropriate technologies as part of a local waste management system" ("Healthcare Waste"). It is especially important in the planning and management of an increase in HCW as a result of the COVID-19 pandemic.

- Stockholm Convention on Persistent Organic Pollutants
    - This convention is an international environmental treaty that is effective from May 2004, aiming to restrict the production and use of persistent organic pollutants (POP) with the goal of total elimination. POPs are any chemicals that are resistant to natural environmental degradation, therefore will accumulate over time and have an adverse effect on human health. Many developing nations (like the ones mentioned previously with the Basal Convention) are decreasing the use of incinerators in hospitals and moving towards the centralized treatment system and shifting towards the use of non-incineration technologies to reduce dioxins release ("International Experience"). To date, the Stockholm Convention is effective in reducing healthcare POPs and mercury wastes.

- Status of health-care waste management in selected countries of the Western Pacific Region
    - The safe disposal of HCW is a global issue that is difficult to be solved by individual member states. Hence, the WHO has issued recommendations on addressing this issue on a regional matter by incorporating 24 Western Pacific Region countries to establish a systematic disposal system through regional dialogues, standardization of the legal and administrative framework, setting up a training system, and further development of action plan ("Status of health-care"). Such solutions are extremely important to developing countries, therefore it is one of the first steps that can be taken in addressing this issue. Refer to Appendix 3 for more details.

Possible Solutions

- In order to promote safe disposal of hazardous HCW, healthcare workers are especially important in being aware of the issue. Therefore, the first step is to provide adequate training and education to healthcare workers and the general public in handling the situation, starting with the skill of identifying and accurately classifying different types of HCW. This is a minimal approach to the disposal of HCW, according to the WHO. Correct segregation of wastes is not only good for the

convenience of disposal but also minimizing the wastes that require specialized treatment. Each type of wastes should be treated with different methods that are most suitable for proper disposal and minimizing environmental harms, rather than being thrown in a pile together to be incinerated.

- In addition to the minimal approach, "other elements of healthcare waste management include waste classification, waste minimization, containerization, color coding, labeling, signage, handling, transport, storage, treatment and final disposal", which requires extensive planning, budgeting, documentation, and most importantly, monitoring ("Healthcare Waste"). Hence, third party monitoring systems can be set up to monitor the progress of HCW management in individual member states.
- Developing member states may particularly struggle with implementing proper disposal methods due to a lack of land area, or lack of funding. With that said, funding will put in place for these LEDCs, managed by a branch of the UN body to ensure rightful and proper use of funding. Furthermore, the UN can encourage more MEDCs to supply basic technological equipment (e.g. autoclave) to LEDCs to deviate from the frequent use of incinerators. Status of health-care waste management in selected countries of the Western Pacific Region is a great example of addressing the issue at a regional matter, rather than by individual states. Such treaties are necessary in other regions of the world as well, to encourage MEDCs to cooperate with LEDCs in setting up a systematic HCW disposal system.
- Change within member states itself is suggested as well, as different countries have different existing laws, acts, and policies in addressing this issue. Therefore, each member states show set clear regulations in the disposal of HCW, by evaluating their existing situation and referring to handbooks and guidelines published by the UN or the WHO.
- Individual countries or relevant UN organizations and local governments can invest in further research in technologies, reducing, reusing, and recycling portions of HCW. Efficiency can be guaranteed by encouraging private firms to invest in research and development as well. Research is especially important not only to develop new technologies but also to find ways in lowering the cost of current technologies or chemicals, making them more affordable by developing countries. Furthermore, finding safe ways to reuse and recycle HCW reduces the amount of wastes released to the environment, and reduces the need for disposing HCW in a crude way.
- Other than targeting hospitals, educating and enforcing the general public in the proper disposal of HCW is important as well. Legal regulations being put in place followed by proper education can prevent many improper disposals of expired drugs that may contaminate water systems or the environment. In addition, reverse distributor services can be established at local pharmacies or waste management companies, so that the public can dispose unopened, expired drugs through the pharmacies.

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"8: Treatment and disposal technologies for health-care waste." *World Health Organization*, www.who.int/water_sanitation_health/medicalwaste/077to112.pdf. Accessed 23 Aug. 2020.

Appendix or Appendices

Appendix 1: Safe management of wastes from healthcare activities

Chartier, Yves, et al., editors. "Safe management of wastes from health-care activities." *World Health Organization*, 2014, apps.who.int/iris/bitstream/handle/10665/85349/9789241548564_eng.pdf?sequence=1. Accessed 17 Aug. 2020.

This 329-page long document published by the WHO provides an extensive guideline to individual countries in promotion of safe disposal of HCW.

Appendix 2: Treatment and disposal technologies for HCW

"8: Treatment and disposal technologies for health-care waste." *World Health Organization*, www.who.int/water_sanitation_health/medicalwaste/077to112.pdf. Accessed 23 Aug. 2020.

This document provides more details into the different types of incinerators used for disposal of HCW and its suitability for different HCW. Details of other types of disposal methods are provided as well. Delegates can refer to this source to understand existing disposal methods and problems associated with it.

Appendix 3: Status of health-care waste management in selected countries of the Western Pacific Region

"Status of health-care waste management in selected countries of the Western Pacific Region." *World Health Organization*, iris.wpro.who.int/bitstream/handle/10665.1/11411/9789290617228_eng.pdf. Accessed 24 Aug. 2020.

Appendix 4: Report of the Special Rapporteur on the adverse effects of the movement and dumping of toxic and dangerous products and wastes on the enjoyment of
human rights

"Report of the Special Rapporteur on the adverse effects of the movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, Calin Georgescu." *United Nations Documents*, 4 July 2011, undocs.org/A/HRC/18/31. Accessed 28 Aug. 2020.