A LEGAL ASSESSMENT OF THE IMPACT OF THE IMPROPER DISPOSAL OF MEDICAL WASTE IN NIGERIA*

Abstract

The United Nations Environment Programme (UNEP) noted recently the importance of proper wastes disposal. They urged governments and other stakeholders to treat waste management, including medical and other hazardous waste, as an urgent and essential public service to minimize their impacts upon human health and the environment. The disposal, as well as the associated environmental and health risks of medical waste, are of global concern. Medical waste may be disposed of using different methods that many countries have adopted. Still, such disposal needs to be done in a manner that neither the environment nor the health states of people are put at risk as they are hazardous. In Nigeria, medical institutions such as hospitals, healthcare centres, healthcare research institutes, health care laboratories, and other health-related establishments generate a sizable amount of medical wastes. These medical wastes pose health risks to humans and the environment if not correctly disposed of. This paper is an assessment of the environmental impacts of improper medical wastes disposal in Nigeria. The researcher made use of doctrinal research approach. This paper is divided into seven sections. Section one is the introductory part, section two gives a detailed classification of medical wastes, and section three examines the medical wastes treatment and disposal practices. Section four discusses the impacts of improper disposal of medical wastes on the environment, section five considers the relevant international conventions with medical wastes related mandates, and section six talks about the statutory regulations with medical wastes associated mandates in Nigeria. This paper concludes in section seven with recommendations.

Keywords: *Medical Waste, Treatment and Disposal of Medical Waste, Environmental Impacts of Improper Medical Waste Disposal.*

1. Introduction

Sustaining a healthy environment is fundamental to increasing the quality of life and years of a healthy life. Internationally, 23% of every death and 26% of deaths among children under age 5 are due to preventable environmental factors.[1] One estimate shows that some 5.2 million people (including 4 million children) die each year from waste-related diseases.[2] However,

* **EMPIRE HECHIME NYEKWERE;** Lecturer, Department of Public and International Law, College of Law, Bowen University, Osun State, Nigeria. PhD Research Candidate (Nnamdi Azikiwe University, Anambra State, Nigeria); LL.M. (University of Ibadan, Oyo State, Nigeria); BL. (Lagos); LL.B. (Obafemi Awolowo University, Osun State, Nigeria). Email: empirehechime@gmail.com

[1]Environmental Health/Healthy People 2020 <https://www.healthypeople.gov/2020/topics-objectives/topic/environmental-health> accessed 3 June 2020.

[2]V E Lekwot, and others, 'Public Health Implication of Improper Hospital Waste Disposal in Zonkwa District of Zangon-kataf Local Government Area, Kaduna State' *Journal of Research in Environmental Science and Toxicology*, 2012, vol 1(1), pp23-28:23.

when we examine the effects of wastes on human lives and the environment, one type of waste is often overlooked: medical wastes.[3] Medical waste includes all the waste generated in the diagnosis, treatment, surgeries, autopsies, or other medical procedures from all types of healthcare institutions, including hospitals, clinics, doctors (dental and veterinary) offices, medical laboratories and research centres related to medical procedures.[4]

As the world's population keeps on growing, the need to provide medical care and services to these people will as well keep on growing together with the added pressure to ensure people are fit and healthy.[5] However, it is now a strange twist that efforts to heal the sick and make people healthier can create wastes products that harm others. Hospitals, health care centres, health care research institutes, health care laboratories, and other health-related establishments generate medical wastes that, if not disposed of properly, can harm those exposed to it.[6] Thus, the proper disposal of medical wastes in a manner that is both safe and healthy, and environmentally-friendly[7] has continued to generate increased public interest. This is due to the environmental and health problems connected with the exposure of human beings to potentially hazardous and infectious wastes arising from medical facilities.[8]

At present, the disposal of medical wastes is a significant issue[9] as it *confers an enormous impact on the environment and a potential risk to human health.*[10] Being hazardous and infectious, the improper disposal of medical waste is a severe environmental impacting problem in terms of water, land, and air pollution, especially in developing countries, including Nigeria.[11] In other words, improperly disposed of medical waste pose health risks to people and the environment

[3]B Allana, 'Clinical Waste-A Major Environmental Burden' <https://www.hospitalhealth.com.au/content/design> accessed 10 June 2020.

[4]See Y Chartier and others (eds), *Safe Management of Wastes from Health-Care Activities* (2nd ed., United Kingdom: World Health Organization, 2014) p. 3; See E O Longe, and A Williams, 'A Preliminary Study of Medical Waste Management in Lagos Metropolis, Nigeria' *Iran J. Environ. Health Sci. Eng*., 2006, vol.3(2),pp133-139:134; S V Manyele, 'Medical Waste Management in Tanzania: Current Situation and the Way Forward' [2004]*African J. Environ. Assessment Manage*, vol 8(1) pp74-99; See A O Adeoye, and E A Akande and A Lateef, 'Impacts of Hospital Waste Management on the Health and Environment of Ogbomoso Area, Oyo State' *Hospice & Palliative Medicine International Journal*, 2018, VOL 2(6), pp386-389.

[5]K Fullerton, The Environmental Hazards of Medical Waste <http://www.senseandsustainability.net/2017/09 /29/dumped-medical-waste-hazardous-to-the-environment/> accessed 28 August 2020.

[6]Medical Waste: Know the Issue <https://noharm-asia.org/content/asia/medical-waste-know-issue> accessed 30 August 2020..

[7]Fullerton, *supra* note 5.

[8]O U A Prosper, and F U Chika, and E N Joachim, 'Knowledge and Practice of Medical Waste Management Among Health Workers in a Nigerian General Hospital' [2014] (5) (12) *Asian Journal of Science and Technology*, 2014, vol 5(2), pp 833-838.

[9]Fullerton, *supra* note 5.

[10]See G D Lanyuy, and F A Jane, and F M Wilfred, F.M. 'Medical Waste Management and Disposal Practices of Health Facilities in Kumbo East and Kumbo West Health Districts' [2017] (9)(1) *International Journal of Medicine and Medical Sciences*, 1-11:2.

[11]G Jibrin. and others. 'Assessing the Impacts of Improper Medical Waste Disposal and Residents Perception of their Disposal Practices in Hadejia Metropolis, Jigawa State, Nigeria'N*igerian Research Journal of Chemical Sciences*, 2018, vol4.pp 26-37; See D O Olukanni, and others. 'Medical Waste Management Practices Among Selected Health-Care Facilities in Nigeria: A Case Study' *Scientific Research and Essays*, 431-439; See Manyele, S.V. 'Effects of Improper Hospital-Waste Management on Occupational Health and S2014, vol 9(10)afety' [2004] (14) *African Newsletter on Occupational Health and Safety*, 30-33; See Awodele, O. and A A Adewoye, and A Oparah, 'Assessment of Medical Waste Management in Seven Hospitals in Lagos, Nigeria' (16)(1) *BMC* , 2016, *Public Health*, 269.

by contaminating the air, soil, and water resources.[12] It is alleged that more than 90% of the waste generated in Nigerian hospitals is directly disposed of improperly on land. Inappropriate disposal of such medical wastes leads to environmental degradation and is a significant source of health hazard.[13] Sound disposal of medical wastes is highly necessary to protect human and environmental health.[14]

2. Classification of Medical Waste

Medical wastes can be classified into the following major groups: sharps waste, infectious waste, pathological waste, pharmaceutical waste, cytotoxic waste, chemical waste, radioactive waste, and non-hazardous or general waste general.

2.1 Sharps Waste

Sharps waste is items that could cause cuts or puncture wounds, including needles, hypodermic needles, and syringes with attached needles, scalpels, and other blades, broken glass, knives, infusion sets, saws, and pipettes. Whether or not they are infected, such objects are generally considered extremely hazardous medical waste and should be regarded and treated as if they were potentially infected.[15]

2.2 Infectious Waste

Infectious waste is waste suspected to contain pathogens **(**bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity, and that poses a risk of disease transmission. This category includes waste contaminated with blood and other body fluids (e.g., from disposed diagnostic samples). Cultures and stocks of infectious instruments from laboratory work (e.g., wastes from autopsies and infected animals from laboratories). Waste including excreta and other objects that have been in contact with patients infected with extremely infectious diseases in isolation wards (e.g., swabs, bandages, and disposable medical devices).[16]

2.3 Pathological Waste

Pathological waste could be regarded as a subcategory of infectious waste but is frequently classified separately-especially when unique methods of handling, treatment, and disposal are used. Pathological waste consists of human tissues, organs or fluids, and body parts. It also consists of human foetuses and infected animal carcasses. Identifiable human or animal body parts are occasionally called anatomical waste. Pathological waste may also include hale and hearty body parts that have been removed during medical procedure or produced during medical research.[17]

---

[12]C N Nkechi and A O Frank and C U Ositadinma , 'Health Care Waste Management - Public Health Benefits, and the Need for Effective Environmental Regulatory Surveillance in Federal Republic of Nigeria' in Alfonso J. Rodriguez-Morales (ed), *Current Topics in Public Health* (Chapter 8, IntechOpen 2013) p. 154;

[13]Jibrin and others, *supra* note 11, pp. 26-27; E Idoteyin, and A Francis, 'Role of National Policy in Improving Health Care Waste Management in Nigeria' *Journal of Health & Pollution*, 2018, VOL 18, NO 19,pp 1-8.

[14]Lanyuy and Jane and Wilfred, *supra* note 10.

[15]Y Chartier and others, *supra* note 4, p. 4; See Ministry of Health Kuwait Manual for Safe Management of Wastes from Health-Care Activities 2016 <http://icdkwt.com/pdf/policiesandguidelines/ICforSupportiveServic es/wastemanagement.pdf)> accessed 21 July 2020.

[16]Ibid.

[17]*Ibid*, p. 5.

2.4 Pharmaceutical Waste

Pharmaceutical waste includes expired, unused, spilled and contaminated pharmaceutical products, drugs, and vaccines that are no longer needed, and, because of their chemical and biological nature, have to be disposed of carefully.[18] This category besides includes discarded objects significantly contaminated throughout the handling of pharmaceuticals, for example, bottles, vials, boxes containing pharmaceutical residues, masks, gloves and connecting tubing.[19]

2.5 Cytotoxic Waste

Cytotoxic wastes are waste containing substances with genotoxic properties, that is, highly hazardous substances that are mutagenic (able to induce a genetic mutation), teratogenic (capable of causing defects in an embryo or fetus) or carcinogenic (cancer-causing). Cytotoxic waste with genotoxic properties may include certain cytostatic[20] drugs, vomit, urine, or feaces from patients treated with cytostatic drugs, cytotoxic[21] (chemotherapeutic[22] or antineoplastic[23]) drugs used in cancer treatment and their metabolites,[24] chemicals and radioactive material.[25]

2.6 Chemical Waste

Chemical waste are waste containing chemical substances such as solvent and reagents laboratory preparations, expired disinfectants, sterilants, and waste with high contents of heavy metals contained in medical devices, e.g., mercury in broken thermometers, batteries, blood-pressure gauges, etc.[26] Chemical waste also consists of discarded solid, liquid, and gaseous chemical from diagnostic and experimental work and cleaning and disinfecting procedures.[27]

2.7 Radioactive Waste

Radioactive waste comprise of products contaminated by radionuclides, including radioactive diagnostic materials or radio therapeutic materials,[28] for example, unused liquids from radiotherapy or laboratory research, contaminated packages, or absorbent papers, glassware, urine, and excreta from patients tested or treated with unsealed radionuclides, sealed sources, etc.[29]

2.8 Non Hazardous or General Waste

Non-hazardous or general waste is waste materials generated from office, kitchen, store and garden that has not been in contact with hazardous substances, infectious agents, or radioactive substances and does not create a sharps risk. A considerable quantity (about 85 percent) of all

[18]*Ibid*; See A Anjali,and A G Vasudha, and J Deepa, 'Impact of Biomedical Waste on City Environment: Case Study of Pune, India' *OSR Journal of Applied Chemistry (IOSR-JAC)*, 2014, VOL 6(6)21-27:26-27.
[19]Y Chartier and others, *supra* note 4.
[20]Cytostatic means suppressing the growth and multiplication of the cell.
[21]Cytotoxic means toxic to the cell.
[22]Chemotherapeutic means the use of chemicals for treatment, including cancer therapy.
[23]Antineoplastic means inhibiting the development of abnormal tissue growth.
[24]The Global Fund, Technical Brief: Sustainable Health Care Management (The Global Fund 2020) p. 31 <https://www.who.int/water_sanitation_health/publications/safe-management-of-wastes-from-healthcare-activit ies/en/> accessed 11 September 2020. (Hereinafter, Global Fund Technical Brief).
[25]Y Chartier and others, *supra* note 4, p. 5.
[26]Global Fund Technical Brief, *supra* note 24, p. 28.
[27]Y Chartier and others, *supra* note 4, p. 4.
[28]Global Fund Technical Brief, *supra* note 24, pp. 31-32.
[29]Y Chartier and others, *supra* note 4, p. 7; See Definition and Characterization of Health-Care Waste <https://www.who.int/water_sanitation_health/medicalwaste/002to019.pdf?ua=1)> accessed 28 July 2020.

waste from medical facilities is non-hazardous waste and is generally similar in features to municipal solid waste.[30]

3. Medical Waste Treatment and Disposal Practices

Treatment of medical wastes has been defined as any method, technique, or process designed to alter the biological make-up or composition of waste to make it non-toxic or non-infectious.[31] Methods of medical wastes treatment are well documented in the literature, but applications varied from countries. The general or standard methods are incineration, burying (landfills), the wastes, open burning, autoclave, chemical treatment, and microwaving.

3.1 Incineration

Incineration is a high-temperature, dry oxidation method that decreases organic and combustible waste to inorganic, incombustible matter and leads to a significant reduction of the volume, weight, and quantity of the waste that have to be disposed of by 75 to 95%. High-heat thermal processes take place at temperatures from about 200 °C to more than 1000 °C. They involve the chemical and physical breakdown of organic material through the processes of combustion, pyrolysis[32], or gasification.[33] Incineration is the most practical means of disposing of hazardous medical waste through high-temperature and burning of solid waste after separating the non-combustibles.[34] An incinerator functions at much higher temperatures than an open fire, so the infectious and medical wastes are eradicated, and the smoke emission is less.[35]

For reasons of emission control and operational safety and reliability, it is desirable to incinerate medical wastes from as many hospitals as possible in one central unit. Emissions in the air, water, and soil are usually reduced by the use of effective and advanced incineration and emission control techniques under technically and economically viable conditions, taking into account the location of the plant. Apart from these polluting emissions, all incinerators produce varying amounts of residues, e.g., bottom ashes or fly ash and particulates captured by pollution control devices. Where these residues exhibit hazard characteristics, they will

[30]*Ibid*, p. 8; See O O Olanrewaju, 'Quantification and Characterization of Medical Waste in Public Health Care Facilities within Akure Metropolis, Ondo State, Nigeria' *EPH-International Journal of Agriculture and Environmental Research* 2019, VOL 5(5), 15-30:16.

[31]See V M Samwel, 'Medical Waste Management In Tanzania: Current Situation and the Way Foreword' <https:// docplayer.net/19348684-Medical-waste-management-in-tanzania-current-situation-and-the-way-forward.html> accessed 13 September 2020.

[32]The decomposition of organic material by heat in the absence of or with a limited supply of oxygen.

[33]Y Chartier and others, *supra* note 4, p. 116; See 'Training Modules in Health-care Wastes Management' <https://www.who.int/water_ sanitation_health/facilities /waste/training_modules_waste_management/en/> accessed 5 November 2020.

[34]A O Awosusi, 'Assessment of Environmental Problems and Methods of Waste Management in Ado-Ekiti, Nigeria' *African Research Review*, [2010] (4)(3b) pp331-343, See generally, UNEP/IETC 'Compendium of Technologies for Treatment/Destruction of Healthcare Waste' (United Nations Environment Programme 2012) <http://wedocs.unep.org/handle/20.500.11822/8628?show=full> accessed 19 August 2020; See Centres for Disease Control and Prevention (CDC)'Infection Control Guidelines' <https://www.cdc.gov/infectioncontrol/gui delines/disinfection/sterilization/steam.html> accessed 10 October 2020; See USEPA, Executive Summary, Draft Environmental Impact Statement on the Upgrading of the Boston Metropolitan Area Sewage System <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey= 91020PAP.TXT> accessed 15 October 2020.

[35]See PATH, 'Designing Safe Syringe Disposal Systems for Immunization Services: A Guide for Programme Managers' (Programme for Appropriate Technology in Health Training Resource Series, October 2003) <https://path.azureedge.net/media/documents/CVP_Sharps_waste_planning_guide.pdf> accessed 29 October 2020.

probably need to be handled as additional hazardous wastes with appropriate environmentally sound disposal methods.[36]

3.2 Burying and Landfills

Burying and Landfills involve the burying of infectious and medical wastes in a pit or an approved landfill site. Landfilling is the most convenient waste disposal technique worldwide. It is recognized as being a valuable option both now and shortly, particularly in low and middle-income countries, since it is the cheapest and the most accessible technology available.[37] A landfill is recognized as the terminal site for all wastes, including ash from incineration and residues from other processes.[38] A standardized landfill system involves a carefully selected location. It is usually constructed and maintained using engineering techniques, ensuring minimized pollution of air, water, and soil and risks to man and animals. It involves placing waste in a lined pit or a mound (Sanitary landfills) with appropriate means of leachate and landfill gas control.[39]

3.3 Open Burning

Medical wastes may be burned in a drum, protected hearth, or an open-pit if it cannot be taken to an incinerator.[40] Uncontrolled and sub-standard burning is extensively practiced creating further environmental problems, as well as the emission of toxic air pollutants (particularly dioxin) and heavy metals, which might be present in gaseous and solid by-products.[41] On inadequately controlled land-disposal sites, the presence of fires and subsurface burning waste poses the additional hazard of airborne smoke. The smoke might contain heavy metals and other chemical contaminants that, eventually, may affect the health of site workers and the general public.[42]

3.4 Chemical Disinfection

Chemical disinfection involves the exposure of infectious medical waste to chemical agents which possess antimicrobial activity. It reduces the pathogenic risk of infectious medical

---

[36]UNEP, Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes' Basel Convention Series/SBC No. 2003/3 (Secretariat of the Basel Convention & UNEP, 2003), p. 35 (Hereinafter, UNEP Technical Guidelines).

[37]E E Ita, and E J Effiom, 'Open Landfill Biomedical Wastes Disposal System and Impact on Health as Perceived by Health Workers' *Journal of Education, Society and Behavioural Science*, 2019] (31)(4) pp1-9; See Virginia's Waste Management & Pollution Prevention <http://www.doe.virginia.gov/instruction/environmental _literacy/va-natural/docs/vnreg-waste-resource.pdf> accessed 17 August 2020.

[38]UNEP Technical Guidelines, *supra* note 36, p. 38; See Safe Management of Waste from Health-Care Activities: A Summary 2017 <https://apps.who.int/iris/bitstream/handle/10665/259491/WHO-FWC-WSH-17.0 5-eng.pdf?s equence=1> accessed 19 November 2020; See United States Agency for International Development (USAID) Sector Environmental Guidelines-Healthcare Waste 2015 <https://usaidgems.org/Sectors/healthcare Waste.htm> accessed 19 November 2020.

[39] E E Ita and E J Effiom, *supra* note 37*;* A O Eludoyin, and O T Oyeku, 'Heavy Metal Contamination of Groundwater Resources in a Nigerian Urban Settlement' *African Journal of Environmental Science and Technology*, 2010, vol 4, no4, pp 201-214.

[40]PATH, *supra* note 35.

[41]Lanyuy and Jane and Wilfred, *supra* note 10, p. 2.

[42]Y Chartier and others, *supra* note 4, p. 31; See generally, International Committee of the Red Cross (ICRC) Medical Waste Management 2011 <https://www.icrc.org/en/doc/assets/files/publications/icrc-002-4032.pdf> accessed 1 October 2020; Global Environment Fund (GEF)/UNDP Technical Specifications for Healthcare Waste Management Equipment 2019 <https://procurement-notices.undp.org/view_file.cfm?doc_id=170571> accessed 1 October 2020.

wastes. General disinfectants may not inactivate organisms such as spores, some fungi, and viruses and are not, in most cases, used as the principal treatment methods. The choice of an appropriate chemical agent and conditions of use are usually determined by the risk assessment, taking into account the following: the identity of the organism(s) to be treated, the nature of the waste and the presence of organic, protein or particulate matter, and the kind of the surfaces, objects or equipment which will be exposed to the chemical disinfectant.[43]

3.5 Autoclaving or Steam Sterilizing

Autoclaving is a low-heat thermal method that is designed to get steam into direct contact with waste for an adequate period to disinfect the waste.[44] The temperature and time of autoclaving depend on the total volume of material to be treated, number and type of organisms, and their resistance against steam. Also, it is necessary first to remove all the air from the autoclave, the waste and the waste containers to ensure that the required sterilization temperature will be maintained. Aesthetic concerns may require that the autoclaved waste is further treated to render it acceptable for final disposal, e.g., if the waste contains human or animal material or tissue. This is because autoclaving may not remove or reduce the non-biological hazards arising from the presence of chemical or physical agents or other elements in the waste.[45] Autoclaving is environmentally safe. In an autoclave, hot pressurized steam kills microorganisms.[46]

3.6 Microwaving

Microwave treatment or microwaving of medical wastes is essentially a steam-based disinfectant process whereby moist heat and steam generated by microwave energy sterilize wastes and destroy infectious agents and pathogenic organisms present in the waste stream.[47] The types of waste generally treated in microwave systems are equal to those operated in autoclaves.[48] Microwave technology has certain benefits, such as the absence of harmful air

[43]UNEP Technical Guidelines, supra note 36, p. 33; See Module 15: Non-Incineration Treatment and Disposal of Healthcare Waste (GEF/UNDP) <https://www.who.int/water_sanitation_health/facilities/waste/module15 .pdf?ua=1> accessed 17 July 2020; See Guidance Note: Material and Waste Inactivation Including Validation Principles for Completion of the Risk Assessment for Genetically Modified Micro-Organisms (GMMs)' (University of Strathclyde 2015) <https://www.strath.ac.uk/professionalservices/media/ps/safetyservices /campusonly/guidancenotes/Waste_inactivation_v4-_GM_guidelines_June_2016.doc> accessed 23 July 2020.

[44]See Training Health Workers in the Management of Sharp Waste: Guide for Training of Waste Handlers <https://docplayer.net/8857969-Guide-for-training-of-waste-handlers.html> accessed 24 July 2020; See generally, WHO, Overview of Technologies for the Treatment of Infectious and Sharp Waste from Health Care Facilities (World Health Organization 2019); International Committee of the Red Cross (ICRC) Sterilization Guidelines 2014 <https://reliefweb.int/sites/reliefweb.int/files/resources/icrc-002-4218.pdf> accessed 21 July 2020. (Hereinafter, ICRC Sterilization Guidelines 2014).

[45]UNEP Technical Guidelines, supra note 36, pp. 32-33.

[46]See Sterilization Guidelines 2014, supra note 44; United States Centres for Disease Control and Prevention (CDC) Guidelines <https://www.cdc.gov/infectioncontrol/guidelines/disinfectio n/sterilization/steam.html> accessed 11 March 2020.

[47]I K M Peter 'Environmental Exposure and Public Health Impacts of Poor Clinical Waste Treatment and Disposal in Cameroon' PhD Thesis: PhD Series A002, Unit for Health Promotion Research (Faculty of Health Sciences: University of Southern Denmark, 2011) p. 10 <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10 .1.1.460.673&rep=rep1&type=pdf> accessed 3 November 2020.

[48]K G Maryam, and B M Y Rosnah 'Advantages and Disadvantages of Healthcare Waste Treatment and Disposal Alternatives: Malaysian Scenario' *Pol. J. Environ. Stud.*, 2016, vol (25)(1) 17-25:20.

emissions, no requirement of chemicals, and reduced volume of waste. However, the investment costs are high presently.[49]

3.7 Inertization

The method of "inertization" entails mixing waste with cement and other substances before disposal to reduce the threat of toxic substances enclosed in the waste migrating into surface water or groundwater. It is particularly appropriate for pharmaceuticals and for incineration ashes with a high metal content (in this case, the procedure is as well called stabilization). For the inertization of pharmaceutical waste, the packaging is usually removed, the pharmaceuticals ground, and a mixture of water, lime, and cement added. The following are usual quantities for the combination: 65% pharmaceutical waste 15% lime; 15% cement; and 5% water. The method is practically less expensive and can be executed using reasonably simple equipment. Excluding personnel, the major necessities are a grinder or road roller to crush the pharmaceuticals, a concrete mixer, and supplies of cement, lime, and water.[50]

4. Impacts of Improper of Medical Waste on the Environment

This section deals with the danger posed to the natural environment by improper medical wastes disposal. Medical wastes are a source of contamination and pollution to both humans and the natural environment. Improper disposal of medical wastes causes all types of pollution, including air, soil or land, and water pollution, as well as environmental health problems such as the transmission of diseases. We shall now examine these pollution types in detail

4.1 Air Pollution

Generally, the medical industry has a significant impact on the environment through air pollution caused by the improper disposal of medical wastes. A disadvantage of the incineration and open-air burning methods of medical wastes disposal is the release of combustion by-products into the atmosphere and the generation of residual ash. The combustion of medical wastes produces mainly gaseous emissions, including steam, carbon dioxide, nitrogen oxides, a range of volatile substances, for example, metals, halogenic acids, and products of incomplete combustion. Also, the burning of medical wastes produces particulate matter, as well as solid residues in the form of ashes that pollute the environment and poses health risks to humans.[51] Reports place the US healthcare system as contributing 9%-10% of National greenhouse gas emissions.[52] In the United Kingdom, it is reported that the National Health Service (NHS) contributes 3-4% of the national greenhouse gas emissions total.[53] Carbon emissions are primarily released by either **incineration, open-air burning,** or

[49]C S Ram Bio-Medical Waste Management Practice and POPs in Kathmandu, Nepal (Centre for Public Health and Environmental Development of Kathmandu, Nepal, July 2007*)* <http://www.noharm.org/details.cf m> accessed 12 March 2020.

[50]Treatment and Disposal Technologies for Health-Care Waste <https://www.who.int/docstore/water_sanitation _h ealth/wasteman ag/ch10.htm> accessed 27 March 2020.

[51]See M Javid, and S Manoj, 'Impact of Biomedical Waste on Environment and Human Health' *Environmental Claims Journal,* 2019. vol(31)(4) pp311-334.

[52]See B Zack 3 Steps to Reduce Hospitals' Environmental Impact <https://www.fiercehealthcare.com/health care/3...> accessed 27 June 2020.

[53]J E Mathew, and S Jodi, 'Environmental Impacts of the U.S. Health Care System and Effects on Public Health' [2016] (11)(6) *PloS ONE* <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157014> accessed 12 November 2020.

through the transportation of medical wastes from the site of generation (doctor's office, clinic, etc.) to a treatment facility, and then to a landfill.[54]

The incineration of medical wastes and open-air burning of medical wastes emits a considerable amount of toxic gases called dioxins into the atmosphere, which is detrimental to both human health and the environment.[55] The Stockholm Convention guidance on best available techniques and best environmental practices states that "If medical waste is incinerated in conditions that do not constitute best available techniques or best environmental practices, there is potential for the discharge of dioxins in relatively high concentrations."[56] Dioxins are a group of highly toxic chemical compounds that are harmful to health and the environment. They are significant persistent environmental pollutants that bio-accumulate in humans and wildlife, highly poisonous and carcinogenic, and may cause developmental, reproductive, and immune system disturbances and problems. Dioxins are by-products of burning processes such as incineration and open-air burning of medical wastes, and they are widely present in the environment.[57] Also, decomposing non-degradable medical wastes release offensive odours which pollute the air, thus rendering the environment unsafe for man.[58]

Further, the open-air burning of medical wastes leads to particulate matter emissions, which are considered a severe threat to both environmental and human health as it releases harmful pollutants that cause various types of respiratory problems such as asthma, chronic bronchitis and heart disease among the residents of the surrounding environment. A study revealed that dust, black carbon, ammonia, sulfate, and nitrate are the dominant species of particulate matter.[59] Particulate matter is the word for particles found in the air, comprising dust, dirt, soot, smoke, and liquid droplets.[60] It is a blend of solid and liquid particles that are suspended in the

[54]**Medical Waste's Impact on the Environment** <https://www.onsitewaste.com/medical-waste-impact-on-the-env ironment> accessed 11 March 2020.

[55]C Bokhoree, and others. 'Assessment of Environmental and Health Risks Associated with the Management of Medical Waste in Mauritius' APCBEE *Procedia*, 2014, vol (9) pp.36-41.

[56] Y Chartier and others, *supra* 4, p. 117; See Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices Relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants (Secretariat of the Stockholm Convention on Persistent Organic Pollutants, 2008) <http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-BATBEP-GUID-GUIDELINES-All.En.pdf> accessed 11 May 2020; See Aerzener M, Heat Recovery from Wastewater Treatment-The Best Practices (Azo Network, 2017) <https://www.azom.com/article.aspx?ArticleID=14864> accessed 3 October 2020.

[57]B Yvette., 'What's to know about Dioxins' *MedicalNewsToday* (Online, *21 April 2017)* <https://www.medical newstoday.com/articles/17685> accessed 15 June 2020; See Canady R and others, 'Safety Evaluation of Certain Food Additives and Contaminants: Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls' WHO Food Additives Series, No. 48 <http://www.inchem.org/documents /jecfa/jecmono/v48je20.ht m> accessed 17 July 2020.

[58] C Bokhoree and others, *supra* note 55.

[59]See Javid and Manoj, *supra* note 50, p. 324; S R B Karthikeyan, and K Iouri, 'Particulate Air Pollution from Bushfires: Human Exposure and Possible Health Effects' [2006] (69)(21) *Journal of Toxicology and Environmental Health*, 1895-908; See What is PM2.5 and Why is it Important <https://www.airveda.com/blog/ what-is-pm2-5-and-why-is-it-important> accessed 21 September 2020.

[60]S Nishant; 'What is the Difference Between PM2.5 and PM10 with Respect to the Atmospheric Pollutants'? <https://www.quora.com/What-is-the-difference-between-PM2-5-and-PM10-with-respect-to-the-atmospheric-p ollutants> accessed 16 July 2020; See PM10 Particles in the Air <https://www.epa.vic.gov.au/for-community/e nvironmental-information/air-quality/pm10-particles-in-the-air> accessed 18 June 2020; See Particulate Matter, State of New Jersey, Department of Environmental Protection Bureau of Evaluation and Planning <https://www.state.nj.us/dep/baqp/particulate.html> accessed 19 July 2020.

air.[61] For example, the open-air burning of medical wastes poses the danger of airborne smoke. The smoke might have heavy metals and other chemical contaminants that pollute the air and, over time, may affect the health of the general public.[62]

Medical wastes incineration is one of the primary sources of mercury release into the atmosphere from healthcare facilities. Medical wastes incineration emit mercury (considered a carcinogen), which results in mercury pollution.[63] Mercury is bio-accumulating and is known to have toxic effects on plants, animals, and humans.[64] Mercury is used in several medical devices, especially fever thermometers and blood-pressure monitoring equipment. These represent a hazard in terms of both breakage and long-term disposal. A less well-known source of mercury in medical wastes is batteries, particularly the small button batteries used in healthcare facilities (hospitals, clinics, health centres, etc.).[65]

Healthcare facilities contribute up to 5% of the release of mercury to water bodies through untreated wastewater. Environment Canada estimates that one-third of mercury load in sewerage systems comes from dental practices. The United States Environmental Protection Agency (USEPA) estimates that medical incinerators may have historically contributed up to 10% of mercury air releases. In the United Kingdom, more than 50% of total mercury emissions come from mercury contained in dental amalgam, and laboratory and medical devices.[66] In a study by the USEPA, medical wastes incinerators are considered to be a significant source of mercury pollution in the environment and food stocks. The USEPA concluded that medical wastes incinerators are the fourth primary source of mercury emissions in the United States.[67]

4.2 Land Pollution

Improper disposal of medical wastes leads to land or soil pollution. The residual materials left after the treatment of medical wastes are carried off to landfills. The majority of treatment processes in use today do nothing to minimize the total mass of what is taken to landfills.[68] Accumulation of toxic chemicals from disposed of medical wastes within soil pollutes and reduces soil quality. Diverse pollutants may get mixed up with the soil and may change the

[61]What is PM2.5 and Why is it Important, supra note 59.
[62]Y Chartier and others, *supra* note 4, p. 30.
[63]V E Lekwot and others, *supra* note 2, pp. 23-28.
[64]H Margot, 'The Environmental Impact of Dentistry' *Journal (Canadian Dental Association)*, 2007, vol(73)(1) pp. 59-62.
[65] Y Chartier and others, *supra* note 4, p. 28; See Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on Batteries and Accumulators and Waste Batteries and Accumulators and Repealing Directive 91/157/EEC. *Official Journal of the European Union*, L 266:1-13 <https://eur-lex.europa.e u/LexUriServ/LexUriServ.do?uri=OJ:L:2006:266:0001:0014:en:PDF> accessed 15 July 2020; See Maine Department of Environmental Protection, 'Mercury-Free Button Batteries: Their Reliability and Availability' Environmental Protection Documents, No. 81, 2009 <http://digitalmaine.com/cgi/viewcontent.cgi?article=1080 &context=dep_docs> accessed 13 October 2020.
[66]Y Chartier and others, *ibid*; See J F Risher, *Elemental Mercury and Inorganic Mercury Compounds: Human Health Effects* (World Health Organization 2003); WHO, Mercury in Health Care Policy Paper (World Health Organization 2005) <http://www.who.int/water_sanitation_health/medicalwaste/mercurypolpap230506.pdf> accessed 17 November 2020.
[67]A A Aymen, and A B Firas, 'Environmental Impacts of Medical Waste Treatment and Management by Burning inside Health Facilities' *International Journal of Civil Engineering and Technology (IJCIET)*, 2018, vol (9)(5) pp.41-53.
[68]Environmental Impact of Medical Waste-Part 1: High Carbon Footprint <https://blog.onsitewaste.com/environmental-impact...> accessed 2 June 2020.

chemistry and biology of the soil ecosystem.[69] Repeated and indiscriminate application of medical chemical wastes over a long period has serious adverse effects on soil microbial population-reducing the rate of decomposition and generally lowering the soil fertility. Pathogens from medical wastes lead to long term accumulation of toxic substances in the soil, which in turn contaminates the soil.[70]

Studies have shown deteriorating soil quality and a decrease in vegetation abundance due to improper dumping of medical wastes. A considerable impact has been noticed in the physical and chemical soil properties close to medical wastes dumping sites.[71] A study investigated the soil contamination by heavy metals through waste disposal of a lead battery used in medical facilities, and the results indicated that lead content exceeded maximum allowable concentrations. Another research determined the level of heavy metal contamination of soil around open landfills and its potential impact on the environment and local society. The result showed that the concentration of different heavy metals was high within the study area.[72]

Further, the environment is being affected and degraded not only because of the emission of dangerous gases from medical wastes incinerators but because the incinerators are designed in such a way that water can get through the incinerators when it rains, resulting in incomplete combustion of hazardous medical wastes. And since medical wastes ashes from incinerators are disposed of in landfills, this may contaminate the land.[73] More so, the combustion products and incinerators of these wastes are sometimes considered to be improper or inadequate, i.e., at fairly low temperatures. These gases are then discharged into the air to be deposited later or transmitted through rainwater to the land or soil, which in turn further contributes to land pollution.[74]

4.3 Water Pollution

Improper medical wastes disposal leads to contamination of water supplies or local water sources used by nearby communities or wildlife.[75] Indiscriminate open dumping of medical wastes contaminates surface and groundwater supplies.[76] Surface and groundwater quality concerns apply to both drinking water and recreational waters.[77] Also, owing to financial constraints, landfills usually lack environmental abatement measures, such as leachate (contaminated water and toxic liquid) collection systems and lining materials. When medical wastes are disposed of in unlined landfills, especially unlined pits when the water table is near the surface, different chemical pollutants or pathogens in landfill leachate may be released into

[69]Javid and Manoj, *supra* note 50; See O O Abidemi, and O C Theresa, 'Environmental Fate of Heavy Metals in Soil of Ido-Osun Waste Dump Site, Osogbo, Osun, Nigeria' *American Journal of Environmental Protection*, 2015, vol (3)(1), pp. 1-4.
[70]Nkechi and Frank and Ositadinma, *supra* note 12.
[71]Javid and Manoj, *supra* note 50, p. 322; S M Ali, and others. 'Open Dumping of Municipal Solid Waste and its Hazardous Impacts on Soil and Vegetation Diversity at Waste Dumping Sites of Islamabad City', *Journal of King Saud University-Science*, 2014, vol (26)(1), pp. 59-65.
[72]Javid and Manoj, *ibid*, p. 323; See J A Adegoke, and T O Owoyokun, and I O Amore, 'Open Land Dumping: An Analysis of Heavy Metals Concentration of an Old Lead-Battery Dumpsite' *Pacific Journal of Science and Technology*, 2009, vol (10)(2) pp.592-595.
[73]C Bokhoree and others, *supra* note 54, p. 39.
[74]Aymen and Firas, *supra* note 66.
[75]G Jibrin and others, *supra* note 11, p. 33.
[76]Ita and Effiom, *supra* note 37, p. 3.
[77]Environmental Health/Healthy People 2020, supra note 1.

surface streams or groundwater which may cause a negative impact on the water quality[78] through contamination of ground and surface water-especially when large amounts are disposed of. This can pose a risk to people who use the water for drinking, bathing and cooking, and destroying animals and plants in the local ecosystem.[79] It has been estimated that waterborne pathogens that contribute to typhoid, cholera, amoebic infections, bacillary dysentery, and diarrhea account for 80% of all diseases in developing countries and at least responsible for up to 90% of the 13 million child deaths each year.[80] Studies have shown that heavy metals in contaminated water and a toxic liquid called leachate were exceeding the drinking water standards.[81]

Further, during heavy rains, medical, chemical wastes such as pesticides stored in leaking drums or turn bags can seep into the ground and contaminate groundwater. This can cause poisoning to anyone through direct contact with a pesticide formulation, inhalation of vapours, drinking contaminated water, or eating contaminated food.[82]Additionally, excreted pharmaceuticals from patients do find their way into waterways, which can contribute to potential environmental severe effects, including toxicity and poisonous to fisheries, wildlife, and the generation of antibiotic resistance in bacteria.[83]

4.4 Environmental Health Problem of Diseases Transmission

Environmental health[84] problem such as the transmission of diseases through hazardous and infectious medical wastes is the most significant and most immediate threat from improper medical wastes disposal. If medical wastes are not treated in a manner that destroys the pathogenic organisms, unsafe numbers of microscopic disease-causing agents-viruses, bacteria, parasites, or fungi will be present in the wastes. These agents can gain entrance to the body through punctures and other breaks in the skin, mucous membranes in the mouth, by being transmitted by a vector organism, being swallowed, or being inhaled into the lungs. Individuals that come in direct contact with the wastes are at the highest risk.[85] Thus, improper medical wastes disposal constitutes a threat to public health because it comprises harmful

[78]Y Chartier and others, *supra* note 4, p. 31; See E But and E Lockley, and K O K Oduyemi,'Risk Assessment of Landfill Disposal Site-State of Art' [2008] (28) *Waste Manage*., 952; T Narayana, 'Municipal Solid Waste Management in India: From Waste Disposal to Recovery of Resources?' *Waste Manage*. 2009] (29)(3),p 1163.

[79]O B Asante and E Yanful, and E B Yaokumah, 'Healthcare Waste Management; Its Impact: A Case Study of the Greater Accra Region, Ghana' [2014] (3)(3) *International Journal of Scientific & Technology Research*, 106-112; See Nkechi and Frank and Ositadinma, *supra* note 12, p. 160.

[80]C N C Ugochukwu, 'Sustainable Environmental Management in the Niger Delta Region of Nigeria: Effects of Hydrocarbon Pollution on Local Economy' PhD thesis, Faculty of Environmental Sciences and Process Engineering, Brandenburg University of Technology Cottbus- Germany, 2008, p. 58.

[81]See Javid and Manoj, *supra* note 50, p. 319; See A H A R Sumaiya. and others. 'Assessment of Heavy Metals in Leachate of an Unlined Landfill in the Sultanate of Oman' *International Journal of Environmental Science and Development,* 2014, vol. (5)(1) pp. 60–63.

[82]Y Chartier and others, *supra* note 4, p. 28.

[83]*Ibid*, p. 34.

[84]Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations. See What is 'Environmental Health'? <http://www.agius.com/hew/resource/envhlth.htm> accessed 14 November 2020.

[85]Nkechi and Frank and Ositadinma, *supra* note 12, pp. 159-160; See WHO, Managing Medical Wastes in Developing Countries: Report of a Consultation on Medical Wastes Management in Developing Countries (World Health Organization 1992) <https://apps.who.int/iris/handle/10665/63022> accessed 11 July 2020.

chemicals that readily affect and enters the environment through different routes of exposure.[86] It is well established that when medical wastes are not properly disposed of, exposure to them could lead to infections, infertility, cancer, dermatitis, asthma, typhoid, cholera, hepatitis, AIDS through injuries from syringes and needles contaminated with human, etc.[87]

Inadequate and improper disposal of medical wastes exposes healthcare workers, patients, waste handlers, and the general public to infections, toxic effects, and injuries.[88] For example, various studies have shown that liquid medical wastes are disposed directly into the municipal sewer system by most medical institutions. And direct disposal of excreta and urine of infectious patients in the municipal sewer system may cause an outbreak of epidemic diseases. Also, the scavengers that engage in recycling operations are unaware of the harmful consequences of exposure to contaminated medical wastes.[89] Thus, scavengers who collect wastes from dustbins and landfills are at risk of injury from infectious medical materials such as sharp instruments, pharmaceuticals and chemicals and direct contact with contagious medical wastes and recycling of infectious objects from landfills is capable of causing disease and illness in man, through direct contact with their users.[90]

5. Relevant International Conventions with Implications for Medical Waste

Several international agreements have been concluded which lay down fundamental principles concerning public health, environmental protection, and the safe disposal of wastes, including medical wastes. These principles and conventions are set out below and must be taken into account in the planning and disposal of medical wastes.[91]

5.1 Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and Their Disposal, Basel, Switzerland, 1989[92]

The Basel Convention seeks to protect the environment and human health against the adverse effects from the generation, management, transboundary movement, and disposal of hazardous and other wastes.[93] This Convention is an international agreement, ratified by some 178 member countries to address the problems and challenges posed by hazardous waste. The Convention was agreed to in 1989 and entered into force on 5 May 1992. Nigeria is a signatory to this Convention. The main goals of the Basel Convention are to minimize the generation of hazardous wastes in terms of quantity and hazardousness, to dispose of them as close to the

[86]G Jibrin and others, *supra* note 11, p. 34.
[87]O O Fadipe, and others. 'Characterization and Analysis of Medical Solid Waste in Osun State, Nigeria' *African Journal of Environmental Science and Technology*, 2011, vol (5)(12) pp.1027-1038:1037.
[88]See O C Abanobi. 'Assessment of Medical Waste Management Practices in Selected Hospitals: A Case Study of Owerri, Nigeria' [2011] (8)(1) *Journal of Environmental Health*, 7-12:7.
[89]Nkechi and Frank and Ositadinma, *supra* note 12, pp. 171-172; B E Bassey, and M O Benka-Coker, and H S A Aluyi, 'Characterization and Management of Solid Medical Wastes in the Federal Capital Territory, Abuja Nigeria' [2006] (6)(1) *African Health Sciences*, 58-63.
[90]See generally A A Issam, and I A Majed, and K Stamatia, 'Assessment of Occupational Health and Safety among Scavengers in Gaza Strip, Palestine' [2020] *Journal of Environmental and Public Health*, 1-9 <https://w ww.hindawi.com/journals/jeph/2020/3780431/> accessed 17 July 2020.
[91]Medical Waste Management (International Committee of the Red Cross 2011) p. 28 <https://www.icrc.org/en /doc/assets/files/publications/icrc-002-4032.pdf> accessed 18 July 2020.
[92]Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Mar. 22, 1989, **S.** Treaty Doc. No. 5, 102d Cong., 1st Sess. (1991), 28 I.L.M. 657.
[93]Basel Convention>Implementation>Publications>Guidance Manual <http://www.basel.int/Implementation/Pu blications/BrochuresLeaflets/tabid/2365/lapg-15499/2/Default.aspx> accessed 15 September 2020.

source of generation as possible, and to reduce the movement of hazardous wastes.[94] In other words, the Convention focuses primarily on the control of transboundary movements but also aims at ensuring the minimization of waste generation as well as its environmentally sound management.[95] Hazardous wastes are wastes that exhibit any of the following hazardous properties: explosive, flammable liquids or solids; poisonous; toxic; ecotoxic; and infectious substances.

Medical wastes or Health Care Related Wastes (HCRW) is one of the categories of hazardous wastes covered by the Convention.[96] Article 4 of the Basel Convention obliges each Party to minimize waste generation and to make sure, to the extent possible, the availability of disposal facilities within its territory.[97] According to the Convention, it remains the responsibility of healthcare establishments to treat and dispose of wastes generated by them in such a way as to guarantee that there would be no adverse health or environmental effects.[98]

5.2 The Stockholm Convention on Persistent Organic Pollutants (POPs), Stockholm, Sweden, 2004

This Convention is a legally binding global treaty aimed at protecting human health and the environment from persistent organic pollutants (POPs). The Convention entered into force on 17 May 2004. POPs are chemicals that stay intact in the environment for extended periods (persistent), become widely distributed geographically in the environment, accumulate in the fatty tissue of living organisms, and are highly toxic to humans and wildlife. POPs circulate globally and can cause damage to the environment wherever they travel.[99]

The aim of the Convention is to eliminate or restrict the production and use of all intentionally produced POPs (i.e., industrial pesticides and chemicals). It furthermore, aims the continuing minimization and, where feasible, ultimate elimination of the release of unintentionally produced POPs such as dioxins and furans.[100] In executing the Convention, Governments will take measures to eliminate or reduce the release of POPs into the environment. For example, under the Convention, the countries party to the treaty are required to use the best available techniques for new medical wastes incinerators. The Stockholm Convention's guidelines for best available techniques and best environmental practices limit the levels of dioxins and furans in air emissions to 0.1 ng I-TEQ/Nm3 at 11% O2.[101]

[94]Nkechi and Frank and Ositadinma, *supra* note 12, p. 164; Extraordinary UN Conference takes Historic Strides to Strengthen Chemical Safety Globally: UNEP and FAO team to promote synergies between the Basel, Rotterdam and Stockholm Conventions in two-week Chemicals and Waste Meeting <https://www.elaw.Org/sys tem/files/In dia+Hazardous+Wastes+Court+Order+657+of+199-2.doc> accessed 19 September 2020.

[95]UNGA, Gaps in International Environmental Law and Environment-Related Instruments: Towards a Global Pact for the Environment (United Nations General Assembly, 30 November 2018) p. 28.

[96]*Ibid.*

[97]I*bid*; See The Hazardous Chemicals and Wastes Conventions <https://www.gdrc.org/uem/waste/all3-overview .pdf> accessed 19 September 2020.

[98]O O Fadipe, and others, *supra* note 87, p. 1036.

[99]Nkechi and Frank and Ositadinma, *supra* note 12, p. 165.

[100]*Ibid.*

[101] Y Chartie and others, *supra* note 4, p. 124.

5.3 The Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam, Netherlands, 1998.

This Convention promotes shared responsibilities and cooperation among parties in international trade of certain hazardous chemicals to protect human health and the environment from potential damage.[102] The Rotterdam Convention was adopted in 1998 and entered into force 24 February 2004. In the 1980s, United Nations Environment Programme (UNEP) and Food and Agricultural Organization (FAO) developed voluntary codes of conduct and information exchange systems, culminating in the Prior Informed Consent (PIC) procedure established in 1989. The Convention substitutes this arrangement with a mandatory PIC procedure and information exchange mechanism on hazardous chemicals and pesticides, together with those used in the medical industry.

Under the Rotterdam Convention on Prior Informed Consent, States are obliged to notify and obtain the consent of importing States to shipments of any chemicals or pesticides that those States have banned or severely prohibited.[103] Article 5 of the Rotterdam Convention requires Parties to inform the secretariat of final regulatory actions taken with regard ot banned or severely restricted chemicals, for the information of other Parties and possible listing under the Convention. Under Article 6 of the Convention, developing countries and countries with economies in transition might in addition propose the listing of severely hazardous pesticide formulations. The Rotterdam Convention applies to any chemical that is banned or severely restricted by a Party.[104]

5.4 The Bamako Convention

Significantly, the adoption of the Bamako Convention by Organisation of African Unity (OAU) now African Union (AU) in 1991 created a regional ban on the importation of all hazardous waste into Africa and limited the transfer of hazardous waste within Africa.[105] Article 4(1) of the Convention states that All Parties shall take appropriate legal, administrative and other measures within the area under their jurisdiction to prohibit the import of all hazardous waste, for any reason, into Africa from non-Contracting Parties. The section further states that such import shall be deemed illegal and a criminal act.[106] Article 4(2) of the Bamako Convention bans explicitly the dumping of hazardous waste, including those generated from the medical industry, at sea and internal waters.[107]

---

[102]Global Fund Technical Brief, supra note 24, p. 15 <http://www.pic.int/TheConvention/Overview/Textofthe Convention/tabid/1048/language/en-US/Default.aspx> accessed 14 July 2020; OHCHR, International Standards <https://www.ohchr.org/EN/Issues/Environment/ToxicWastes/Pages/Standard s.aspx> accessed 13 June 2020.

[103]B Jutta. 'The United States and International Environmental Law: Living with an Elephant' [2004] (15)(4) *EJIL*, 617-64 9:625.

[104]Nkechi and Frank and Ositadinma, *supr*a note 12.

[105]Bamako Convention on the Ban of Import into Africa and the control of Transboundary Movement of Hazardous Wastes Within Africa, Jan. 29, 1991, 30 I.L.M. 773 [Hereinafter, Bamako Convention]; See Matiangai, V.S.S. 'Criminalization of Trafficking in Hazardous Waste in Africa', p. 10 <www.africancourtrese arch.com>2016/07> accessed 16 June 2020.

[106]Bamako Convention, ibid, art. 4(1).

[107]*Ibid*, art. 4(2).

5.5 Convention On Access to Information, Public Participation in Decision-Making And Access To Justice In Environmental Matters (The Aarhus Convention)

The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters was agreed to on 25 June 1998 in Aarhus at the 4th Ministerial Conference in the 'Environment for Europe' process.[108] This Convention grants the public rights and imposes obligations regarding access to information and public participation and access to environmental justice.[109] Article 1 of the Convention states that to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the rights of access to information, public participation in decision-making, and access to justice in environmental matters in accordance with the provisions of this Convention.[110] From the provision of article 1, it is clear that this Convention grants the public the right to access environmental information and participate in environmental decision making that is likely to affect their health and well-being. The Convention also gives the public the right to access justice, in the form of redress and remedy, if they are denied their right of access to environmental information and participation in environmental decision-making that is likely to affect their health and well-being.

5.6 Minamata Convention on Mercury[111]

The Minamata Convention on Mercury is a universal treaty that aims to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.[112] It was decided at the fifth session of the Intergovernmental Negotiating Committee on Mercury in Geneva, Switzerland, on 19 January 2013 and adopted later that year on 10 October 2013 at a Diplomatic Conference held in Kumamoto, Japan. The Convention entered into force on 16 August 2017. The Convention draws attention to an international and ever-present metal that, while naturally occurring, has extensive uses in daily materials and is discharged to the atmosphere, soil, and water from a diversity of sources.[113]

Controlling the anthropogenic releases of mercury all through its lifecycle has been a critical factor in shaping the obligations under the Convention. Significant highlights of the Minamata Convention include the phase-out and phase-down of mercury use in several products and processes, control measures on emissions to air and releases to land and water, and the

---

[108]Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters [Aarhus Convention] <https://www.europeansources.info/record/convention-on-access-to-information-public-participation-in-decision-making-and-access-to-justice-in-environmental-matters-aarhus-convention/> accessed 13 July 2020.

[109]Global Fund Technical Brief, supra note 24, p. 15 <https://www.unece.org/env/pp/treatytext.html> accessed 27 July 2020.

[110]The Aarhus Convention, art. 1 <https://www.unece.org/fileadmin/DAM/env/pp/documents/cep43e.pdf> accessed 18 July 2020.

[111]Minamata Convention on Mercury, art. 4 (1), annex A, part I <https://www.unenvironment.org/resources/rep ort/minamata-convention-mercury> accessed 21 July 2020.

[112]*Ibid*, art. 1.

[113]Global Fund Technical Brief, supra note 24, p. 15 <http://www.mercuryconvention.org/Convention/Text/tab id/3426/language/en-US/Default.aspx> accessed 11 November 2020; See Munyaradzi Musiiwa, 'Miners Decry Mercury Ban' *The Sunday News* (Online, 23 October 2016) <https://www.sundaynews.co.zw/miners-decry-mer cury-ban/> accessed 23 November 2020; See UNEP-UNITAR Mercury Platform <https://mercury.unitar.org/sit e/event/1352> accessed 27 November 2020; See Text and Annexes - Minamata Convention on Mercury Home <http://mercuryconvention.org/Convention/Text/tabid/3426/language/en-US/Default.aspx> accessed 21 October 2020.

regulation of the informal sector of artisanal and small-scale gold mining.[114] The Convention, in addition, deals with the interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury plus health issues. It deals with the harmful effects of mercury on human health and environment. The Convention strongly advocates for the finding of the alternative of mercury and its compound or supports the act finding of non-mercury technologies in manufacturing processes. Signatory countries to the Convention are to undertake measures to reduce the human and environmental impact of anthropogenic mercury.[115]

6. Statutory Regulations with Medical Waste Related Mandates in Nigeria

The foundation of environmental policy in Nigeria is contained in the Constitution of the Federal Republic of Nigeria 1999. The state is empowered in section 20 of the Constitution to protect and improve the environment; and safeguard the water, air and land, forest, and wildlife of Nigeria. Hitherto, various laws and regulations have been enacted to protect the Nigerian environment. The laws and regulations with medical wastes related mandates are as discussed below.[116]

6.1 National Environmental Standards and Regulations Enforcement Agency (NESREA ACT), 2007

The National Environmental Standards and Regulations Enforcement Agency was established pursuant to the NESREA Act of 2007 and has as its objectives the duty for the protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources in general and environmental technology, plus coordination and liaison with significant stakeholders within and outside Nigeria on matters of enforcement of environmental standards, regulations, rules, laws, policies, and guidelines.[117] Section 7(d) of the NESREA Act provides explicitly that the Agency shall enforce compliance with policies, standards, legislation, and guidelines on water quality, environmental health, and sanitation, including pollution abatement (reduction).[118] Environmental health, which is a branch of public health concerned with the studying, monitoring or mitigating of those factors in the environment that influences or affects human health and diseases,[119] is specifically mentioned in section 7(d) of the NESREA Act as one of the areas covered by the NESREA.

6.2 National Environmental (Sanitation and Wastes Control) Regulations S. 1. No. 28 2009

The regulations are organized into seven parts, with eighteen schedules, and with broad application to issues of environmental sanitation and particularly to food, market, and industrial

[114]Ibid.

[115]S Anwar, **'**Minamata Convention on Mercury: Objectives and Significance' (Jagran Josh, 28 February 2018) <https://www.jagranjosh.com/general-knowledge/minamata-convention-on-mercury-objectives-and-sig nificance-1519823784-1> accessed 20 December 2020.

[116]Nkechi and Frank and Ositadinma, *supra* note 12, p. 168; See Nigerian Regulatory Bodies (Rain Forest 2012) <http://www.rainfores-tlimited.com/contactus.html.> accessed 27 November 2020; See Environmental Policy and its Enforcement in Nigeria <http://www.elri-ng.org/content/Environmental%20Policy%20and%20its%20% 20Enforcement.pdf> accessed 13 October 2020; See M Oghogho and A Temitope, Environment Law In Nigeria -Energy and Natural Resources <https://www.mondaq.com/nigeria/energy-law/53804/environment-law-in-nige ria> accessed 17 June 2020.

[117]NESREA Act, Cap. F10, Vol. 1, 2004, section 2.

[118]I*bid*, section 7(d).

[119]See Environmental Health <https://www.lexico.com/definition/environmental_health> accessed 23 November 2020.

wastes and sanitation, the different categories of wastes therein generated with particular reference to community, end-of-life, hazardous, healthcare, industrial, radioactive, leaf and yard, solid and packaging wastes. The regulations also make provisions, among other things, for control of solid waste, effluent discharge, and hazardous and healthcare wastes.[120]

Part 3(IV) of the National Environmental (Sanitation and Wastes Control) Regulations specifically provides for Medical or Health Care Waste (HCW) Control.[121] Regulation 55 provides that no person shall own or operate any facility that treats health care waste without a valid license issued by the Agency. Regulation 56 provides that any facility that generates health care waste shall ensure that the generating facility is registered with the relevant Authority.[122] Regulation 61 provides that within six months of the commencement of these Regulations, existing operators of healthcare waste management facility shall submit Environmental Audit Reports and, after that, submit such Reports, every three years to the Agency. Regulation 62 provides that all healthcare waste management facilities shall submit a waste management report quarterly to the relevant Authority.[123]

6.3 The National Environmental Protection (Pollution Abatement in Industries & Facilities Generating Waste) Regulation S. I. 9 of 1991

The regulations prohibit the release of hazardous or toxic substances into the environment beyond the limits approved by the Agency. It requires that solid, liquid, and gaseous discharge should be analyzed and reported to their nearest office and oblique factories to submit yearly environmental audit report within 90 days of demand by the Agency.[124] Regulation 1 of the National Environment Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations restricts the release of toxic substances and states that no industry or facility shall release hazardous or poisonous materials into the air, water or land of Nigeria's ecosystems beyond limits approved by the Agency.[125] Regulation 11 provides that the collection, treatment, transportation, and final disposal of waste shall be the responsibility of the industry or facility generating the waste.[126] The waste referred to in these regulations include waste. The ultimate duty lies with the producer, as under Nigerian law, the "polluter pays" principle applies.[127]

6.4 National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations S.1. 15 of 1991

The objectives of the National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations are to identify solid, toxic and extremely hazardous wastes dangerous to public health and environment; provide for surveillance and monitoring of dangerous and

[120]I Nnamdi, 'Safe Disposal of Municipal Wastes in Nigeria: Perspectives on a Rights Based Approach' Afe *Babalola University: Journal of Sustainable Development Law and Policy*, 2014, vol (3)(1)72-86:79, 81.
[121]See generally, Regulations 54-62.
[122]National Environmental (Sanitation and Wastes Control) Regulations 2009, Regulations 55 & 56 (Hereinafter, Sanitation and Wastes Control Regulation).
[123]Sanitation and Wastes Control Regulations, Regulations 60, 61 & 62.
[124]Nkechi and Frank and Ositadinma, *supra* note 12, p. 168; See Vision Statement of the Federal Ministry of Environment 2012 <http://directory-nigeria.org/federal-ministry-of-environment-housing-and-urban-dev.html> accessed 25 September 2020.
[125]Sanitation and Wastes Control Regulations, Regulation 1.
[126]Sanitation and Wastes Control Regulations, Regulation 11.
[127]M Oghogho and A Temitayo, The International Comparative Legal Guide to Environmental Law 2008: A Practical Insight to Cross-Border Environment Law (Chapter 41-Nigeria, Global Legal Group 2008) p. 300.

extremely hazardous wastes and substances until they are detoxified and safely disposed of; provide guidelines necessary to establish a system of proper record keeping, sampling, and labelling of dangerous and extremely hazardous wastes; develop suitable and provide requirements required to facilitate the disposal of hazardous wastes, and research into possible reuse and recycling of hazardous waste.[128]

6.5 National Environmental Health Practice Regulations 2016

The purpose of the National Environmental Health Practice Regulations is to, among other things, prevent and control the incidence of contagious diseases through environmental health intervention and to reduce environmental hazards to health, safeguard and maintain the aesthetic value of the environment.[129] The National Environmental Health Practice Regulation 35(1) provides for the establishment of a Waste Management Advisory Committee, which shall advise on and carry out advocacy support functions on environmental health services and, in particular, waste management.[130] Part III of the National Environmental Health Practice Regulations provides for the collection and disposal of solid wastes. Regulations 14(1) ensure that no person shall dispose of any waste, whether solid or liquid, in any place except as approved by the Environmental Health Authority responsible for the area.[131] Regulation 15 provides that no person shall litter waste of any description on any street, premises, drainage, water bodies, or public place.[132]

6.6 Nigerian Radioactive Waste Management Regulations 2006 Issued Pursuant to the Nuclear Safety and Radiation Protection Act 1995

The Nigerian Nuclear Regulatory Authority (NNRA) was established in May 2001 in accordance with the Nuclear Safety and Radiation Protection Act 1995[133] and charged with the responsibility for nuclear safety and radiological protection regulation in the country.[134] NNRA is statutorily mandated to ensure the protection of life, health, property, and the environment from the harmful effects of ionizing radiation at the same time as allowing beneficial practices involving exposure to ionizing radiation.[135] Section 47 of the Act empowers the NNRA to, with the approval of the President, make regulations prescribing anything required under the Act. Subsequently, the Nigerian Radioactive Waste Management Regulations 2006 was made and gazetted by the Justice Ministry.[136]

The Regulations establish the fundamental technical and organizational conditions to be complied with by waste generators and operators of waste management facilities to ensure the

[128]The National Environmental Protection (Pollution Abatement in Industries & Facilities Generating Waste) Regulation 1991, Regulation 1; See Environmental Policy and its Enforcement in Nigeria <http://www.elri-ng.o rg/content/Environmental%20Policy%20and%20its%20%20Enforcement.pdf> accessed 25 November 2020.

[129]National Environmental Health Practice Regulations 2016, Regulations 1(c) & (d).

[130]*Ibid*, Regulation 35(1).

[131]*Ibid*, Regulation 14(1).

[132]*Ibid*, Regulation 15.

[133] Nuclear Safety and Radiation Protection Act, CAP N142, LFN 2004.

[134] O N Okafor , Nigeria's Experience with Implementing the Code of Conduct and the Joint Convention on the Safety of Radioactive Waste and Spent Fuel in Relation to Nigeria's Management in DSRS' DSRS Workshop, Lisbon, Portugal 11th-15th October 2010 <https://www-ns.iaea.org/downloads/rw/waste-safety/workshops/lisbon 2010/monday/nigeria.pdf> accessed 23 May 2020.

[135]Y Idris 'Nigeria Radioactive Wastes Management Regulations 2006' 2nd National Seminar on Nuclear Power Programme: Legislative and Regulatory Requirements, Nigeria 2008 <https://inis.iaea.org/search/search. aspx?orig_q=RN:39068379> accessed 29 July 2020.

[136]Okafor, *supra* note 134.

protection of human health and the environment from the hazards connected with radioactive waste within and beyond Nigeria's borders.[137] These regulations apply to all users of sources of ionizing radiation in medicine, industry, teaching, research, agriculture, hydrology, geology and other field of human activity whenever such uses are subject to registration or licensing under these Radioactive Waste Management Regulations.[138]

Under these regulations, radioactive wastes are classified using the several categories which include:

(a) According to its physical form and composition;
(i) Solid waste,
(ii) Liquid aqueous waste,
(iii) Liquid organic waste,
(iv) gaseous waste,
(v) sealed radioactive sources,
(vi) biological waste (e.g. animal carcasses which might undergo decomposition if not properly treated and stored), and
(vii) medical waste (e.g. syringes, bed linen and contaminated clothing from a hospital environment).[139]

Regulations 6(1) provides that the primary responsibility for the safe management of radioactive waste rests with the waste generator who shall take all necessary actions to ensure the safety of radioactive waste unless the responsibility has been transferred to another person or organization as approved by the Authority.[140] Regulations 16 provides for discharge or release of radioactive substances to the environment and states that a licensee shall ensure that radioactive waste shall not be discharged or released into the environment unless: (a) the waste activity or concentration are confirmed to be below clearance levels as prescribed by the Authority; and (b) discharge of liquid or gaseous effluents is within the limits authorized by the Authority.[141]

7. Conclusion

It is safe and sound to conclude that owing to the toxic, hazardous, and infectious nature of medical waste; improper disposal leads to the destruction of the natural environmental and human health. This may eventually disrupt the balance of the existing ecosystem with the associated health and environmental risk. Medical waste has caused the challenge of maintaining the quality of water, air, and soil. Hence, the urgent need for proper waste disposal strategies to protect human health and environmental safety.[142] Disposing medical waste properly will help reduce or eliminate the problems posed by improper disposal on the environment and human health. It can avert adverse health and environmental effects from such waste, as well as the unintentional discharge of biological or chemical hazards, including drug-resistant microorganisms, into the environment thus protecting the environment and public health.

Considering the scale of medical waste generated in Nigeria, it is imperative to take this issue as a topmost priority. There is need for training in the area of waste treatment and disposal for

[137]Nigerian Radioactive Waste Management Regulations 2006, Regulation 2; See Status of Licencing DSRS Storage Facility in Nigeria <http://www-ns.iaea.org/downloads/rw/code-conduct/waste-code/presentations/mon day/nigeria.pdf> accessed 29 October 2020.
[138]*Ibid*, Regulation 4(2)(b).
[139]I*bid*, Regulation 5(a) (i)-(vii).
[140]*Ibid*, Regulation 6(1).
[141]*Ibid*, Regulations 16(1) (a) & (b).
[142]V E Lekwot and others, *supra* note 2, p. 28.

hospital workers. Also, educating the public and local sensitization campaigns such as town hall meetings on the dangers of medical wastes could help the public avoid preventable risks. Adequate medical waste treatment and disposal is the solution to safeguard the Nigerian environment and provide healthy, hygienic living environments for the citizens. Thus, the government, environmental regulatory agencies, and medical care institutions in Nigeria must rise to the challenges of environmental pollution caused by medical waste generated from healthcare facilities.[143]

8. Recommendations

1. Government should show a stable political and economic will by developing a robust and enforceable policy on medical waste treatment and disposal.

2. Government should invest in both human and material resources in the medical sector.

3. The Federal Ministry of Health and the Federal Ministry of Environment should collaborate with government and private hospitals, clinics, health centres, and other health-related institutions to invest in environmentally safe and cost-effective medical care waste treatment and disposal technologies.

4. Environmental regulatory agencies, for example, the National Environmental Standards and Regulatory Enforcement Agency (NESREA) should effectively monitor and follow-up medical care institutions (medical laboratories, hospitals, pharmaceutical companies etc) to ensure environmental friendly medical waste treatment and disposal.

5. Government should initiate and encourage continuous seminars, training, and awareness campaigns for hospital workers and members of the public to raise awareness about methods of preventing environmental pollution and disease transmission from medical wastes.

6. Government should encourage professionalization and commercialization of the medical sector, taking into consideration the 3Rs (reduce, reuse, and recycle) mantra of waste management by exploring research to convert medical wastes into energy and other useful products.

[143]See WHO; 'Water, Sanitation, Hygiene, and Waste Management for the COVID-19 Virus: Interim Guidance',(World Health Organization, 19 March 2020) p. 4 <https://www.who.int/publications-detail-redirect/water-sanitation-hy giene-and-waste-management-for-the-covid-19-virus-interim-guidance> accessed 21 September 2020.