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Impact of Biomedical Waste on Environment and Human health: A Review

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Abstract: Biomedical waste (BMW), if not managed properly, will pose significant environmental and health impact. Healthcare establishments have particular responsibilities with respect to the wastes they generate however, the impact of biomedical waste has not been given significant attention. Negligence in biomedical waste management contributes to environmental pollution, sickness of humans/animals, and depletes natural as well as financial resources. Poor handling of BMW pose health hazard to the hospital staff, rag-pickers, municipal workers and the community. This review focuses on impact of BMW on the environmental parameters such as water, air, soil and on human health.

Keywords: Biomedical waste, Disease, Environmental impact, Health hazard, Infection, Resistant pathogen

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Introduction

The growth of the medical sector around the world combined with an increase in the use of disposable medical products has contributed to the large amount of medical waste generated. Medical waste is considered as a source of contamination of land and water sources if not rendered harmless before it is buried in land or disposed in water. Hospitals and nursing homes generate increasing amount of BMW in an unscientific manner. Poor waste management practices by health care establishments cause exposure to health hazards and actual environmental problems (Javid and Sharma, 2019).

Poor management of BMW causes environmental pollution, unpleasant smell, growth and multiplication of insects, rodents, and worms, and may lead to transmission of diseases like typhoid, cholera, and hepatitis through injuries from sharps contaminated with blood (Babanyara *et al*., 2013). Although hospitals protect and save human life, the by-products generated (sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical tools and radioactive

substances) cause great damage to the environment (Manyele and Mujuni 2010; Rodriguez 2013).

Sharma *et al*. (2013) stated that out of the total wastes generated by healthcare organizations, 10–25% are biomedical wastes which are hazardous to humans and the environment and requires specific treatment and management. Javid and Sharma (2019) reported that BMW has caused challenge to maintain the quality of water, air, and soil. The quantities and proportions of different constituents of wastes, their handling, treatment, and disposal methods in different healthcare settings varies and treatment and disposal methods have been found to be inadequate in most of the studies.

Health care facilities generate many types of liquid, solid and gaseous waste in large quantities. Medical waste is considered to be a part of hazardous waste because of its negative impact on workers in health institutions, society and public health if not properly managed. Lack of sufficient awareness about the seriousness of medical waste, which has led to poor application of waste management systems properly, especially in the countries of the third world (Aymen and Bajari, 2018).

According to Babu *et al*. (2009), improper management in BMW causes stern environmental problems that causes to air, water and land pollution. One of major causes for the increase in infectious diseases is improper waste management. Infections and diseases spread due to improper waste management of BMW include tuberculosis, pneumonia, diarrhoeal diseases, tetanus, whooping cough etc. Proper management of BMW is a concern that has been recognized by both government agencies and the Non-government organizations.

Hospital waste is a potential health hazard to the health care workers, public and flora and fauna of the area. The problems of the waste disposal in the hospitals and other health-care institutions have become issues of increasing concern (Mathur *et al*., 2012). The objective of this article was to review the impact of BMW on the environmental parameters such as water, air and soil with a special emphasis on human health.

Definition of Biomedical waste:

Biomedical waste refers to all waste, biological or non-biological, that is discarded and not intended for further use (CDC, 2003; Odumosu, 2015). It is also referred to as hospital waste (Chandrappa and Das, 2012), or medical waste (Aymen and Bajari, 2018) or health-care waste (HCW) (Ansari *et al*., 2019).

BMW comprises of human anatomical waste, animal waste, microbiology and biotechnology wastes, waste sharps, discarded medicines and cytotoxic drugs, soiled waste, solid waste (wastes generated from disposable items other than the waste sharps), liquid waste, incineration ash and chemical waste (Chandrappa and Das, 2012).

The present paper provides an overview on the major issues and debate, gaps in knowledge and way to bridge the gap related to BMW with respect to impacts on environment and human health (Table1).

Research methodology:

Review method adopted was based on the scientific literature survey from databases such as Medline, Embase, PubMed Central, ScienceDirect, Proquest and Medscape. The keywords used for reviewing the literature were the ones that refer to the issues concerning the BMW. For literature search, keyword "biomedical waste" is combined with health risk to the environment and human.

Impact of biomedical waste on the Environment:

A healthy environment is the prime requirement for healthy living. The waste generated in different hospitals are directly or indirectly linked with the human environment. It may harm the environmental integrity if not collected and removed in accordance with the rules (Javid and Sharma, 2019). Eckelman and Sherman (2016) noted that the emissions from healthcare sector is

Table 1: Structure of the review paper

Section	Subsection	Details
I	Introduction	• Introduction of Biomedical waste (BMW) • Definition of BMW • Goal of the present review paper.
II	Research methodology	• Scientific literature survey from databases. • Medline, Embase, PubMed Central, ScienceDirect, Proquest and Medscape.
III	Impact of BMW on the Environment	• Impact of BMW on Water • Impact of BMW on Soil quality • Impact of BMW on Air quality
IV	Impact of BMW on Human health	• Spread of Infection and Disease • Spread of Resistant Pathogen • Dangers to the Public

responsible for acid rain, greenhouse gas (GHG) emissions, smog formation, air pollutants, stratospheric ozone depletion and carcinogenic and non-carcinogenic air toxics. The improper management of BMW causes serious environmental problems in terms of air pollution, water pollution, land pollution and soil pollution (Bhatia and Paul, 2017).

Impact of biomedical waste on Water:

- Negative impact on the water quality due to leach out of pollutants from the waste dumping sites into the ground water (GW).
- Contamination by heavy metals (Al, V, Cr, Mn, Co, Ni, Ba, Pb and Fe) (Al Raisi *et al*., 2014).
- Pollution due to polycyclic aromatic hydrocarbons (PAHs) (Heera and Rajor, 2014).
- Pollution by PAH, Polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDD/Fs), polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and ashes (Ansari *et al*., 2019).
- Pollution by dioxins and furans (Babu *et al*., 2009).
- Contamination by pathogens [Hepatitis C (HCV); Human immunodeficiency virus (HIV); total coliforms (TC) and *Escherichia coli* (Chandrappa and Das, 2012; Ansari et al, 2019)].
- Contamination by toxic pollutants and chemical disinfectants (WHO, 2021).
- Mercurial pollution of surface water (ICRC, 2011).

Impact of biomedical waste on Soil quality:

- Change in quality of soil near waste dumping sites (Javid and Sharma, 2019).
- Impact on physical and chemical properties of soil due to excess nitrates and phosphates (Babu *et al*., 2009; Ali *et al*., 2014).
- Contamination by heavy metals (Ag, As, Ba, Bi, Cd, Cr, Cu, Mn, Ni, Pb, Ti, Sb, Sn, Sr and Zn) (Abidemi and Theresa, 2015; Ansari *et al*., 2019).
- Deterioration of soil quality and decrease in vegetation (Ali *et al*., 2014).
- Pollution by infectious waste, discarded medicines and chemicals (Babu *et al*., 2009).
- Contamination by metal salts of Al, Ca, Fe, K, Mg and Na (Javid and Sharma, 2019).
- Pollution by metal salts of Al, Ca, Fe, K, Mg and Na (Ansari *et al*., 2019).
- Mercurial pollution due to accumulation of methylmercury (ICRC, 2011).

Impact of biomedical waste on Air quality (*Javid and Sharma, 2019*):

- Pollution by GHG, particulate emissions, dust, black carbon, ammonia, sulfate, and nitrate.
- Contamination by hazardous organic compounds (diethyl phthalate, decane, dodecane, octane, nonane, methenamine, cyclobutane, carbon disulfide and acetone diperoxide).
- Pollution by hydrochloric acid, carbon monoxide, ethane, ethylene, propane, and propylene.
- Contamination by bioaerosols, pathogens, dioxins and furans.
- Contamination by particulate matter, metals, acid gases, oxides of nitrogen, sulfur and xenobitic substances. (Sharma *et al*., 2013).
- Deterioration by acid gases, global warming, acidification, photochemical ozone or smog formation (Aymen and Bajari, 2018).
- Contamination by criteria gases (SOx, NOx, CO_2, CO, etc.) from bottom or fly ashes (Blahuskova *et al*., 2019).

Impact of biomedical waste on Human health:

Hasan *et al*. (2015) noted that despite the implementation of BMW management and handling rules by the Government of India, the BMW management still remains a serious issue due to the lack of awareness, improper knowledge and practices among the health care personnel. Inefficient handling and management of BMW may lead to spread of disease and infections, environmental pollution and pose highest risk to health-care staff, rag pickers and scavengers, municipal workers and the public (Odumosu, 2015). It also causes global rise in infections (AIDS and Hepatitis B), changes in microbial ecology and spread of antibiotic resistance (Shakira *et al*., 2018).

ICRC (2011) documented that all persons who are in contact with hazardous BMW are potentially exposed to the various risks. These groups include:

- persons inside the establishment generating the waste.
- persons who handle the waste.
- persons outside the facility who may be in contact with hazardous wastes or their by-products.

BMW pose dangers to the public by spread of infection and disease, spread of resistant pathogen and dangers to the public (Odumosu, 2015).

Spread of Infection and Disease (*Odumosu, 2015*):

- Transmission of infectious agents like blood-borne pathogens via BMW.
- Infection of HIV, hepatitis C and hepatitis B from needle-stick injury from a contaminated syringe.
- Infection by opportunistic pathogens from medical devices (hypodermic needles, blades, etc.).
- Spread of infection and disease through vectors such flies, mosquitoes, insects and mammals (monkeys, bats).
- Transference of zoonotic diseases (avian flu, H1N1) to human by animals (dogs, cats, rats, cattle, goats, birds, elephants etc.).
- Transmission of contracting diseases (tuberculosis and anthrax) from the meat of infected animals.

Spread of Resistant Pathogen (*Odumosu, 2015*):

- Antibiotic-resistant pathogen affect the flora and fauna by increasing the pathogenic strains of hospital origin and decreasing the commensals.
- Contamination of the groundwater, streams, and rivers via flooding.
- Drug resistant bacteria (*Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter* spp. etc.) contaminate the water, making it unfit for drinking.

- Public health is affected through the spread of antibiotic-resistant genes.
- Cause therapeutic failure among infected individuals.

Dangers to the Public (*Odumosu, 2015*):

- Water contaminated with pathogens from BMW results in sickness and other ailments (tuberculosis, typhoid, water borne diseases).
- Public health risk due to repackaging of used medical equipments (syringes, hypodermic needles, expired drug) by rag pickers and scavengers for resale.
- Outbreak of diseases due to reusing syringes and by transacting in second-hand syringes.
- Infections, infertility, genital deformities, hormonally triggered cancers, mutagenicity, dermatitis, asthma and neurological disorders (Javid and Sharma, 2019).
- Typhoid, cholera, hepatitis, AIDS, bronchitis, anthrax, allergy and other viral infections from the sharps contaminated with blood (Cebe *et al*., 2013).

Conclusion

Many scientific studies have reported the hazards associated with poor BMW management and limitations of the existing system of treatment and disposal. Effective implementation of policies, plans, and protocols is necessary for sustainable management of BMW. Organization of training programs on proper waste management for all healthcare workers and active participation of all hospital staff is recommended. Environmental awareness and consciousness about biomedical waste is taking roots in health sector and general public. Waste Management Hierarchy provided by United States Environment Protection Agency (EPA) with a preference for source reduction and reuse, recycling/composting, energy recovery and treatment and disposal is recommended to minimize the quantities of biomedical waste.

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