MEDICAL WASTE GENERATION AND MANAGEMENT: A DESCRIPTIVE REVIEW

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ABSTRACT

The objective of this study is to find out the present scenario of medical waste management around the world and waste disposal methods that have been used and possible ways for Bangladesh. The findings of this paper, narrate merits and demerits, hazardous consequences of mismanagement of these methods, and advice for sustainability and importance of medical waste management. Medical waste is a subset of garbage and waste produced by healthcare departments like hospitals, doctor's offices, blood banks, etc. According to the current scenario, the waste generation rate is in alarming stage. A systematic review has been performed to analyze the present scenario of medical waste management. PRISMA method was followed for the selection of literature. Based on the inclusion and exclusion criteria, the literatures were selected. The whole study is conducted with the available knowledge and current practices of several countries including medical waste types (Sharps & Needles, Glass, Anatomical Remains, Plastic, Body Parts, Bandages, Blood Bag, Gloves, Patient Kits, Laboratory Fluids, etc.), generation rate with area and corresponding methods (Incineration, Landfills, Pyrolytic combustion, Chemical Disinfection, Steam Sterilization, Microwave Sterilization, Dry Heat Disinfection etc.) to decompose the wastes. The findings of this study introduce types, and methods and narrate their merits-demerits, as well as possible advice and solutions, related to medical waste management, by utilizing environment-friendly technologies for efficient medical waste treatment and disposal methods, furthermore serve as a link between the healthcare system, decision-makers, and stakeholders. This paper presents an overview of the generation rate and the current management practices of medical waste in some countries. Among the methods mentioned above, incineration, landfills, and combustion are the most frequently used and effective waste management systems according to our findings. An outline for future studies on the rate of medical waste generation is represented by the study that should be investigated in future work to establish a database inventory.

Keywords: *Medical Waste (MW), Medical Waste Management (MWM), medical waste management methods.*

1. INTRODUCTION

If a waste demonstrates any of the traits listed above, including being combustible, reactive, explosive, corrosive, radioactive, infectious, annoying, or bio-accumulative, it is deemed hazardous (G LaGrega, M. D., Buckingham, P. L. and J. C. Evans, n.d.). In recent times, medical waste has gathered the attention of environmentalists, scientists, and researchers. In hospitals, various therapeutic procedures are carried out, producing infectious wastes, sharp objects, radioactive wastes, and chemical materials. If Medical Waste Management (MWM) is not properly maintained, the incremental garbage will sow the seeds of diseases, as well as after producing a huge amount of MW, spreading diseases, and exponential death rates will break, the situation cannot be handled within a short time. For instance, the recent break out of COVID-19 made the whole world witness this situation. Therefore, MWM must act in accordance. The classification of Medical Waste is based on the existence of biologically aggressive medications, sharps, and the presence of infectious substances regarding infectious waste, pathological waste, chemical waste, sharps waste, general waste, etc. *(Health-Care Was*te, n.d.). For example, Infectious waste such as discarded diagnostic samples, infected animals from laboratories, swabs, and bandages. Pathological Waste such as waste of human or animal body. Chemical Waste like mercury in broken thermometers and batteries, Sharp Waste such as needles, syringes glasses. Pharmaceutical Waste like outdated or leftover drugs/ vaccines. General Waste such as non-recycle-able household waste.

From the very beginning hospitals and other healthcare institutions are the main contributors to medical waste *(Health-Care Was*te, n.d.). In addition to increasing the number of patients, population growth has also increased the amount of garbage produced. Hospital trash up to hundreds of tons per day must be properly treated and disposed of (Ferdowsi et al., 2013). A survey shows that hospitals in Bangladesh produce a total of 5562 kg of waste every day, of which around 77.4% are non-hazardous and approximately hazardous percentage is 22.6%. The typical rate of waste generation in the hospital is 1.9 kg per bed per day or 0.5 kg per patient per day (Hassan et al., 2008). In the Covid-19 pandemic waste generation multiplied by many times. For instance, in Wuhan, China waste generation increased by 600% when Covid-19 out broke (Jiajun, 2020). Generally, in sewers or drains, all hospitals release their liquid pharmaceutical and chemical waste since none of them possess any suitable liquid. (Dana, 2011) Hospital waste has traditionally been dumped in landfills along with other municipal rubbish. But for its fatal effect, MW should therefore be handled differently and cannot be combined with regular trash (Altin et al., 2003). The local authorities should be in charge of treating infectious trash, and hospital administration should generally organize the collection of infectious and other wastes separately (Agency, 1986).

There are many suitable methods for MWM. Sanitary landfills and incineration are the most used medical waste disposal methods around the world. (Hong et al., 2018) . The goal of our paper is to inform the reader about various technological options to treat a specific type of MW which may be followed by the authorities and countries.

2. METHODOLOGY

A systematic review process was followed to achieve the desired outcomes while completing the review paper. We carried out the relevant information from the databases “Research Gate”, “PubMed”, “Google Scholar”, and “Science Direct”. In the databases, we searched for “medical waste”, “management”, “Hospital waste” etc. From the search, we came out with (n=148) papers. Initially, we screened out some of the papers (n=118) by reading the title and abstract. After that, the remaining papers (n=26) went through some specific inclusion and exclusion criteria to meet the standard requirement. In extension, due to the COVID-19 pandemic recent year papers were also included to get new and technological ways of MWM. The papers having the proper mention of medical waste generation and description of suitable methods of disposal were prioritized. After screening out according to inclusion and exclusion criteria (n=19) papers were selected to complete the study. In the selection segment, compulsory keywords (Medical Waste, Medical Waste Management, etc.) have gained more importance, and more cited papers and recent year papers are included (After the year: 2000) in our paper. On the contrary, irrelevant titles and abstracts are

excluded from the study. For the analysis, the methodology was conducted by following the PRISMA chart(Page et al., 2021). The following chart describes the whole process in a nutshell.

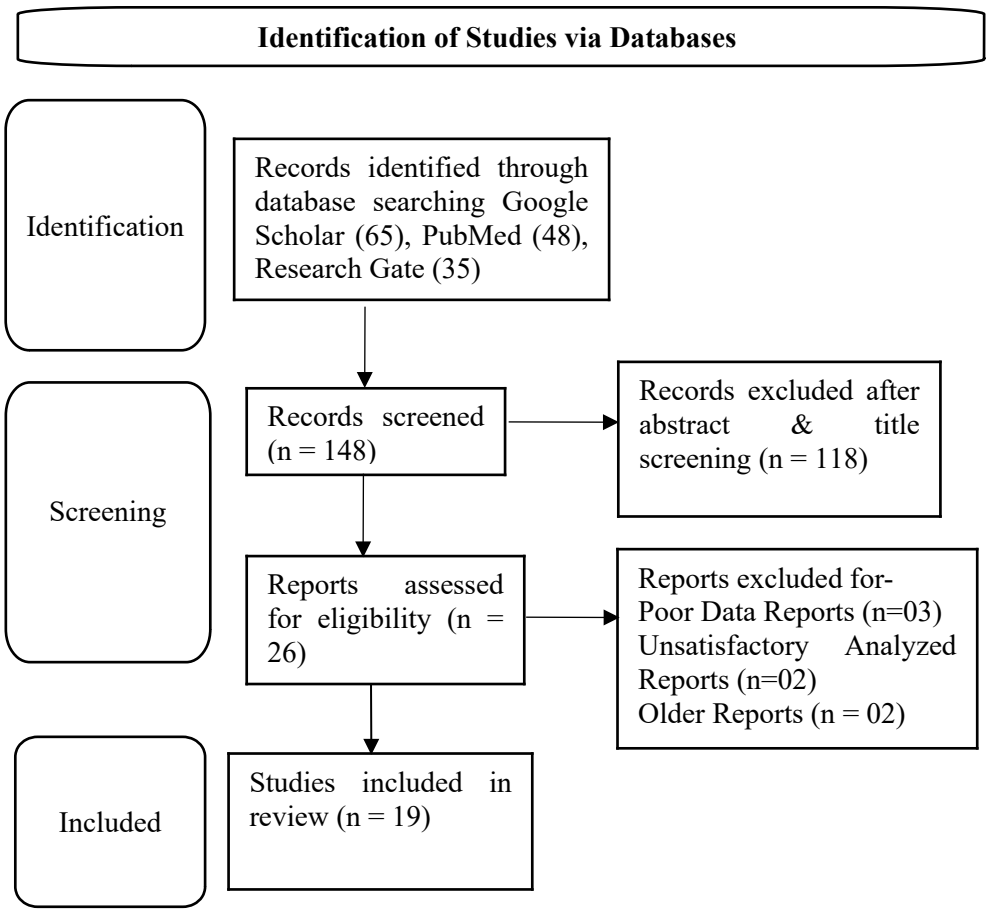

Figure 1: PRISMA chart for identification of studies.

The following Table 1, lists the studies along with how many papers from each were used for the review process. The conducted study was focused on Medical Waste generation and MWM, not on the transportation, selected methods to dispose of, specific areas, and environmental and economic effects.

Table 1. Table for number of papers/journals/articles selected.

Name of the country	Number of the study (Article /paper/Journal)
Portugal	1
Turkey	1
Greece	1
China	2
Korea	1
Bangladesh	4
Ethiopia	1
India	2
Pakistan	2
Morocco	1
Jordan	1
African countries	2
New York, USA	2
England	1

3. RESULT

4. Table showing waste type, generation, and disposal method collected from articles of different countries.

The following table is arranged according to MW type, generation, and disposal method. During the study, it was found that, in most of the waste disposal methods, the ultimate destination of the waste is landfills. In fact, after burning or incinerating the waste, the fly ash or residue is disposed of in landfills. In the mentioned papers, incineration is found to be the most convincing method of waste disposal. In China, Israel, Turkey, Portugal, and Korea incineration has broadly been used. In Greece, Portugal and Bangladesh landfill method has used frequently. Methods like pyrolytic combustion, autoclave, and chemical disinfection are getting their proper importance in recent times. Prosperous countries like China are using this kind of new and effective disposal techniques for disposing of MW.

Name of the	Area	Method	Type Of Waste	Waste

paper/ Reference				Generation
(Altin et al., 2003)	Four hospitals in Sivas, Turkey	Incineration	Plastic (41%), Food (17%), Paper (16%), Textile (10%), Glass (7%)	985kg/day.
(Alvim-Ferraz & Afonso, 2005)	Hospital of Portugal.	Controlled air incineration & ash disposal in Landfill.	Plastic (27%), Paper (20%), Swabs & absorbents (27%), Fluids (16%), Sharps & needles (4%), Glass (2%)	300-bed hospital of which Segregation 3.9 kg/(bed day) Rigorous Segregation 3.8 kg/(bed day)
(Lee et al., 2002)	5 typical hospitals & medical centers and 3 animal hospitals in Massachusetts	Recycle of plastic waste	Plastic Wastes (IV bags, Sharps, Blood Bag, Patient Kits, Gloves, etc.) (100%)	Operating room (110.6tons/year) Emergency room (26.4tons/year) Laboratory (132tons/y)
(Israel Deneke Haylamicheal et al., 2011)	9 healthcare facilities including hospitals, health centers, and higher clinics in Hawassa city, Ethiopia.	Low combustion, single chamber, brick incinerators, and open burning of the medical waste.	0.24kg/day sharps 1.27kg/day infectious waste 1.75kg/day general waste.	A median of 226.9kg/day.
(Yong et al., 2009)	Nanjing, China	Incineration, steam sterilization microwave sterilization, chemical disinfection, dry heat disinfection.	Average type of waste	0.68kg/Year-bed
(Jang et al., 2006)	Korea	Only incineration technologies have been implemented by the three disposal companies in Nanjing	Total waste in 2002	33981 ton/year
(Tsakona et al., 2007)	Chania, Crete, Greece	Local Sanitary, Landfill disposal	Municipal Waste (bottle, battery product packaging)	7 kg/day-bed
(Singh et al., 2020)	Wuhan, China.	Mobile Incinerator, Autoclave Steam, Dry Heat, Chemical Disinfection or Microwave	Discarded PPEs Such as Face Masks, Gloves, and Other Contaminated Single-Use Protective Gear.	247 tons/day of medical waste in Wuhan, China.

The following pie and bar chart shows the waste generation and disposal method in Dhaka City, Bangladesh according to a survey in 2006 (Hassan et al., 2008). Laboratory wastes go to sewages, and hazardous waste including infectious, sharp, plastic, liquids handled with Pyrolytic combustion. But this does not represent the whole scenario of Bangladesh about MWM.

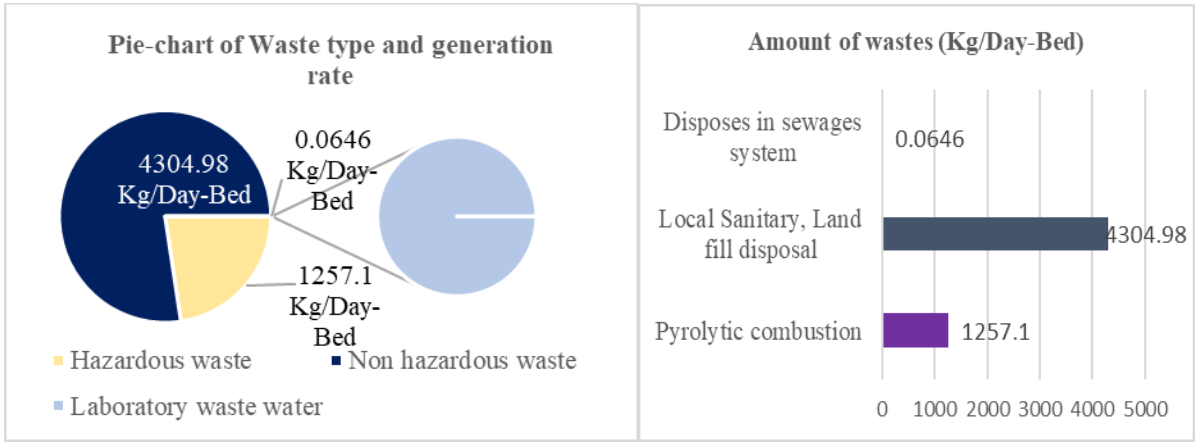

Figure 2: Waste type and generation rate in Dhaka city, Bangladesh (Hassan et al., 2008).

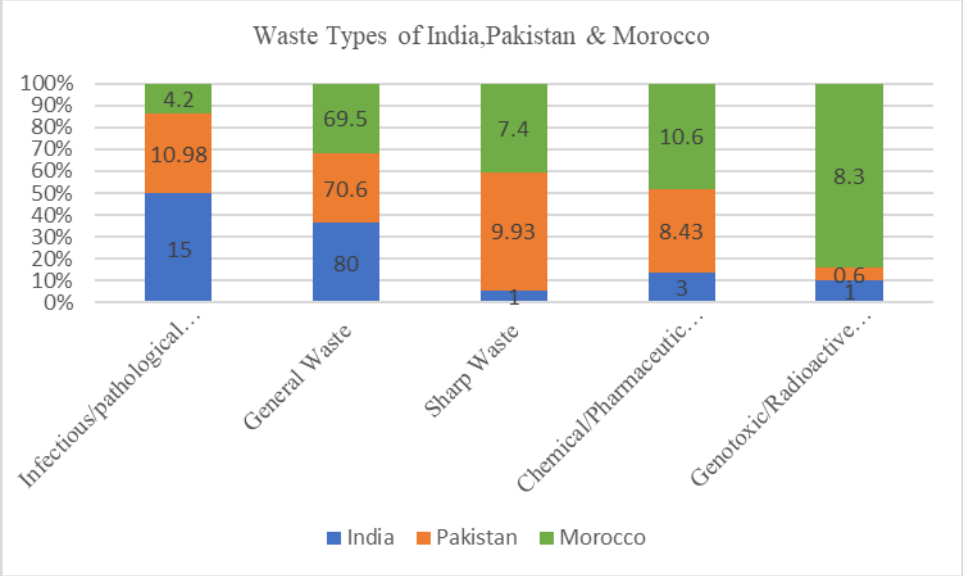

Figure 3: Waste types of India, Pakistan & Morocco (Patil & Shekdar, 2001) (Mukhtar et al., 2018) (Mbarki et al., 2013).

The figure shows the waste type generated in three countries which explains infectious wastes are in large number in 15% and are in lowest quantity in Morocco. India is creating most of the general waste. Next, sharp waste is in great amounts in Pakistan and Morocco while it is minimum in India. Chemical waste is generated in large amounts in Morocco, then Pakistan and India in the least. It is shown from the graph that Genotoxic/ Radioactive waste is produced in huge amounts in Morocco. In India for overpopulation and lack of proper handful workers procrastination in MWM is often noticed (Patil & Shekdar, 2001). In Pakistan, most of the MW is managed by incineration and ashes into landfills. The rest waste is dumped in open areas which is quite harmful to the environment and leads to chronic diseases to spread out again (Mukhtar et al., 2018). There is comparatively a systematic way for MWM in Morocco. According to MWM legislation, MW are collected in separate colored bags for different types of waste in Morocco. (Mbarki et al., 2013). The appropriate method by law for pharmaceutical in incineration. But in practice, these wastes are sent to open land disposal.

5. DISCUSSIONS

The findings of Table 3.1 are the different types of medical waste disposal methods that have been applied in different countries. The above-mentioned methods are Incineration, Landfills, Pyrolytic Combustion, Steam Sterilization, Microwave Sanitation, Chemical Disinfection, Dry Heat Disinfection etc. Landfills and incineration are the most commonly used waste disposal methods among the listed countries. Though in many countries they are not the major method of disposal but waste goes through one of these methods. Recycling is also an effective way of waste but it's not convenient for all wastes as all wastes can't be recycled. Incineration is the most used method among the countries but it has environmental impact and it's not easy to clean the product of incineration. As technology advances, new methods are being introduced and already some countries have adopted those methods like autoclave, chemical disinfection, pyrolytic combustion, steam sterilization, etc. But the scenario of Bangladesh is quite disappointing which is shown in the bar graph. Instead of adapting new methods of waste disposal, the country is still struggling to properly collect and manage the waste.

6. CONCLUSIONS

This review paper implies many directions on suggesting MW generation and its disposal methods. So, this paper puts emphasis on various suitable economical and environment-friendly MW disposal methods. Improper treatment of MW has harmful consequences on the environment, including wildlife, water quality, and the high potential of disease transmission. In fact, most of the MW collecting persons are illiterate and don't even know about the hamper it can cause. MW must be distinguished from municipal garbage, yet in many places, it is frequently collected with the other waste streams. Medical staff, patients, and the general public adversely can be affected by improper MWM. Additionally, because MW is poisonous, poor management might alter the ecosystems' delicate equilibrium. The study's findings make it clear that medical waste management is not carried out by advised standards. When deciding on the best method for disposal, decisions about its storage, transportation, and contamination must take into account aspects like pollution and cost in addition to the cost of disposal. Our study has focused on the generation rate of MW and its management system in some areas around the world. Our study also recommends to build a relationship between waste generation, collection, storage, transportation, and the maintenance of the system as a whole. The available method's advantages and disadvantages narrated in the study help one to choose a specific method for a definite type of MW.

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