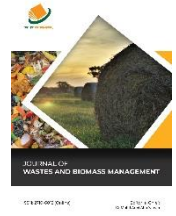


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RESEARCH ARTICLE

REVIEWING CLINICAL WASTE MANAGEMENT UNDER THE LEGISLATIVE FRAMEWORK IN PAKISTAN: PRACTICES AND CHALLENGES

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ABSTRACT

The waste generated at healthcare facilities has two distinct categories: hazardous and non-hazardous waste. 10- 15% of the total waste generated at hospitals is hazardous which is termed as clinical waste. This review article has reported and reviewed the practices of clinical waste management in Pakistan's major cities. Researches demonstrated that about 1.35 Kg / bed waste has been produced by the tertiary health care facilities in Pakistan. Studies for review process are selected through an iterative process. More than 100 research articles, National legislations, international protocols and newspaper reports are consulted and reviewed to extract the data of interest. Clinical waste management in Pakistan is the responsibility of the individual health care facility producing it under Hospital Waste Management Rules, 2005. Due to lack of proper checks and weak implementation of legislations many gaps have been identified in this review article like lack of segregation, inappropriate vehicles for transportation, poor storage and no advanced pollution control treatment strategies. Most of the hospitals lack documented waste management plan. Staff was mostly untrained and under educated. International standards for safe hazardous waste disposal are not being followed resulting in spread of diseases like hepatitis and AIDS. Cases of poor recycling and reuse of used clinical instruments is also documented. However, the condition is much satisfactory in big cities. There is an understanding to focus on the proper implementation of clinical waste management rules with strict checks. Establishment of incineration facility at major hospitals with proper maintenance, safe transportation to secure landfills and utilization of proper SOPs are suggested improvements towards safe management of clinical waste.

KEYWORDS

Incineration, Risk-waste, Landfill, Segregation, Implementation gaps.

1. INTRODUCTION

Hospitals are center of contaminations and thus waste produced from hospitals is likely to spread transmittable ailments with harmful consequences for the public as well as the atmosphere. Waste management is a substance of substantial community health and environmental apprehension (Habibullah and Asfar, 2007; Maina, 2018; Tiwari and Kadu, 2013). According to a World Health Organization (WHO), waste from health-care services contains 75-90% non-hazardous waste, while the remaining is considered hazardous (Chartier *et al.*, 2013; Ali *et al.*, 2016). WHO has stressed that healthcare wastes should be handled as distinct waste. The US Environmental Protection Agency (EPA) has also defined health wastes as infectious (Ali and Kuroiwa, 2009; Hossain *et al.*, 2011).

In 2009, research was directed by a management association in Pakistan which depicted that about 2-4 tons of waste is produced each day by numerous health facilities out of which 10-25% is risk for public health, termed as clinical waste, and needs careful disposal (Khattak, 2009). Clinical waste is a main cause of infections among patients, paramedical workers and the public (Ansari *et al.*, 2015; Chartier, 2014; Habib-Ullah and Khan, 2011; Caniato *et al.*, 2016). Waste production depends on

several aspects such as procedures of waste management, kind of hospital institutions, quantity of recyclable objects hired in hospital, hospital specialization, and percentage of patients treated daily (Suwannee, 2002; Ezeoke *et al.*, 2017).

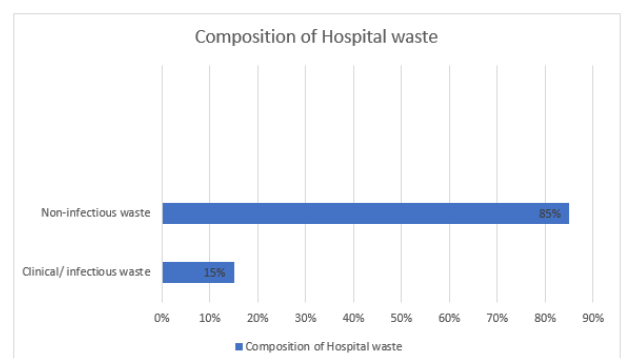


Figure 1: Composition of Waste Generated by Hospitals Worldwide ((Khattak, 2009; Ali, 2018; Hakim *et al.*, 2014).

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Medical waste constitutes human blood products and even blood, infectious agents stock, cultures and contaminated wastes, , soiled sharps laboratory wastes, pathological wastes from healthcare, rejected organic, dirtied animal corpses, body fragments and bedcovers, dirty equipment and assorted infectious wastes (Habib-Ullah and Khan, 2011; Thakur and Ramesh, 2015; Di *et al.*, 2012). Toxic waste also arises amid reagents (predominantly lab reagents), medications, and mercury thermometer (WHO, 2004; Bello *et al.*, 2011).

Pakistan is the 6th highly populated country in the biosphere, it is among the countries having maximum expansions and urbanizations in South Asia (Ali *et al.*, 2016; The World Bank, 2010–2014a; 2010–2014b). The circumstances related to Hospital Waste Management (HWM) in progressing countries are dissenting with set administration methods (Lima Moura *et al.*, 2018). Inopportunately, Pakistan is amongst nations where much attention is not paid to management of waste (Khan *et al.*, 2019; Mathur *et al.*, 2012). Few studies have exposed that management of Clinical waste is not upto the Environmental Protection Agency (EPA) criteria in developing countries like Pakistan (WHO, 2011; Ezeoke Uchchukwu *et al.*, 2017).

Several studies from Pakistan stated that most of the hospitals and autonomously working doctors do not exercise appropriate methods for handling the waste and removal which results in the unswerving and recurrent contact of patients, physicians, visitors and other people around to infectious hospital waste (Janjua, 2003). A regulation in the form of article naming "Hospital Waste Management Rules, 2005" from government is existing. These rules were testified by the Ministry of Environment in August 2005 (Khan *et al.*, 2016).

Researches demonstrated that about 1.35 Kg / bed waste has been produced by the tertiary health care facilities in Pakistan. Around 92,000 beds are existing only at the tertiary hospitals of communal segment in Pakistan that generate 0.8 million tons of hospital waste each day (Kumar *et al.*, 2015). Some reports in Pakistan depicted that about 2.0 Kg of waste/bed/day is formed out of which 0.1-0.5 Kg can be characterized as hazardous waste (Arshad *et al.*, 2011). Mishandling of the clinical waste cause the spread of several lethal illnesses like Hepatitis B, C, and AIDS (Khan *et al.*, 2019; Wiener-Well *et al.*, 2011). In Pakistan spread of diseases is also observed due to risk waste. Scavengers collect used syringes for recycling and re-selling them in the marketplace for individual monetary motives (Kumar *et al.*, 2010; Khan *et al.*, 2006; Usmani *et al.*, 2010).

2. MATERIALS AND METHODS

This review paper has been written to find, authenticate, and categorize chief practices and their related challenges that are important for clinical waste management in unindustrialized countries, explicitly in Pakistan and predominantly its major cities. The researches contained within this review article are those available in recent years. This is done to find current inclinations and practices for final disposal of hazardous wastes. Most of the researches nominated for this review paper encompassed data regarding collection, segregation, transportation, storage and disposal practices of clinical waste. Henceforth the articles selection shadowed an iterative process (Goldsby *et al.*, 2017; Gonzalez *et al.*, 2019; Guzman *et al.*, 2020; Xiong *et al.*, 2019) in which non-appropriate papers were left out from successive researches. At the end a sum of 100 research papers were taken. This review article also has assisted in the documentation of derelictions made by healthcare employees and facts concerning hospital unused discarding.

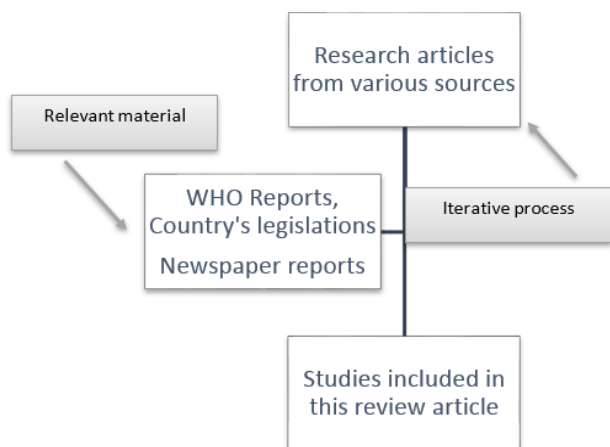


Figure 2: Selection of Published Articles for this Review Paper

3. RESULTS

3.1 Stages of Clinical Waste Management practices in Pakistan

According to 3rd provision of Hospital Waste Management Rules 2005, every hospital shall be responsible for the waste produced by it. Medical superintendent in each hospital is held responsible to have a team for proper waste management in hospitals. Most of the prevailing researches on the subject of hospital waste organization in Pakistan are subjective (Kumar *et al.*, 2015; Ali *et al.*, 2016a). In Pakistan hospitals yield about 250,000 tons of waste each year. Hospital waste has been informed to be poorly tackled and managed by the hospital employees and management correspondingly (Kumar *et al.*, 2010).

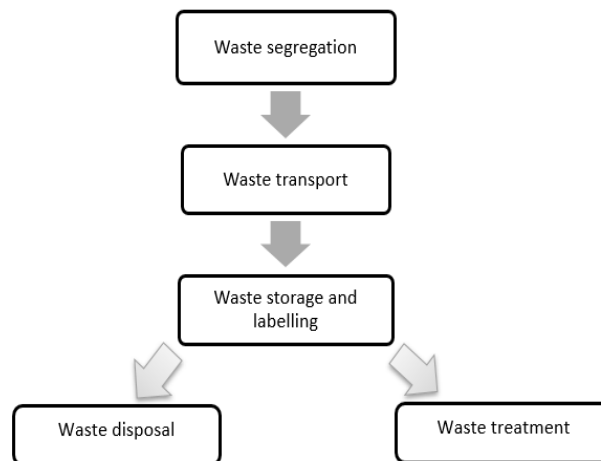


Figure 3: Stages of Clinical Waste Management (Mukhtar *et al.*, 2018; Yazle *et al.*, 2019; Kumar *et al.*, 2012).

3.1.1 Segregation of clinical waste

Waste segregation is a vital step in management plan of hospital waste. Hospital Waste Management rules 2005, Section 16, consists of 8 regulations for the separation of medical waste. Segregation is defined as the isolation of infectious waste from non-hazardous waste at the point of generation (bedside in wards, laboratory, operation theatre or any other chamber in the hospital), by the doctors, nurses, or other paramedical staff creating the waste (Arshad *et al.*, 2011).

Table 1: Segregation practices in Different cities of Pakistan (Rasheed *et al.*, 2005; Anwar *et al.*, 2013; Kumar *et al.*, 2015; Amin *et al.*, 2013; Arshad *et al.*, 2011; Zeeshan *et al.*, 2018; Khan *et al.*, 2019; Badar *et al.*, 2014).

| City | Segregation practices |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Gujranwala | Medical waste separation is being done by the nurses. Sharp objects separation and color-coding scheme is being followed in only few hospitals |
| Faisalabad | In Faisalabad, segregation of waste is only 23.3%. Therefore, risk and non-risk waste is assorted together. |
| Rawalpindi | Each section has color codes according to international standards; yet, there wasn't any appropriate cataloging on the containers. |
| Peshawar | Color coding patterns are reported to be followed by only 40% of the hospitals in Peshawar for the segregation of clinical waste. |
| Abbottabad | The separation of clinical waste after gathering it in an isolated storing room situated within the hospital in maximum hospitals is observed. |
| Islamabad | Separation was described to be appropriate according to the color-coding scheme. |
| Lahore | Waste segregation in different colored containers like red, yellow and black was experienced in 80% hospitals |
| Hyderabad | Most of the clinics in Hyderabad City are not compliant to segregation practices |
| Bahawalpur | That 50% public sector hospitals were segregating hospital waste whereas the percentage is only 16.6% for private hospitals |

In Gujranwala city, Medical waste separation is being done in every area by the nurses. Sharp objects separation and color-coding scheme is being followed in only few hospitals (Rasheed *et al.*, 2005). In Faisalabad, segregation of waste is only 23.3%. Therefore, risk and non-risk waste is assorted combinedly, becoming more injurious for humans and environment (Anwar *et al.*, 2013). In an investigation of 2 chief hospitals in Rawalpindi, each section has color codes according to international standards; yet, there wasn't any appropriate cataloging on the containers (Kumar *et al.*, 2015).

Color coding patterns are reported to be followed by only 40% of the hospitals in Peshawar for the segregation of clinical waste (Amin *et al.*, 2013). Khan *et al.* 2019 reported that the seclusion of clinical waste after gathering it in an isolated storing room situated within the hospital in maximum of the hospitals in Abbottabad. In Islamabad separation was described to be appropriate according to the color-coding scheme. Arshad *et al.* 2011 reported that waste segregation in different colored containers like red, yellow and black was experienced in 80% hospitals situated in Lahore (Arshad *et al.*, 2011). A study conducted in Peshawar District revealed that most of the healthcare units are not practicing the set separation standards and color-coding methods for handling the clinical waste (Zeeshan *et al.*, 2018). Most of the clinics in Hyderabad City are not compliant to segregation practices (Khan *et al.*, 2019a). Badar *et al.* 2014 observed a total of 48 hospitals (24 private and 24 public division) to look into the infectious waste supervision practices in Bahawalpur city, the investigation revealed that 50% public sector hospitals were segregating hospital waste whereas the percentage is only 16.6% for private hospitals (Badar *et al.*, 2014).

- Categories for the segregation of Biomedical Waste as per WHO Standards

Clinical waste is unsafe and hazardous which stances grave intimidations to atmosphere. It necessitates precise pre-handling and supervision former to its concluding clearance. In order to diminish the danger to human life and environment, it is essential that hospices treat and dispose of the waste bestowing to the global and nationwide ideals (Ali *et al.*, 2015; Ali and Kuroiwa, 2009).

Table 2: Protocol for The Color Codes and Type of Containers Used for Disposal of Biomedical Waste (Ali *et al.*, 2015; Pakr, 2010; Sapkota *et al.*, 2014; Ali *et al.*, 2017; Ali *et al.*, 2018; Yadavannavar *et al.*, 2010).

| Container type | Color code | Category of waste | Treatment |
|------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Plastic bag/ disinfected container | Red | <ul style="list-style-type: none"> • Solid and soiled waste • Microbiological and biological wastes | <ul style="list-style-type: none"> • Autoclave • Microwave • Chemical treatment |
| Plastic bags | Yellow | <ul style="list-style-type: none"> • Human and animal waste • Biological and microbial wastes • Soiled wastes | <ul style="list-style-type: none"> • Deep entombment • Incineration |
| Plastic container | Green | General waste of hospital (non-infectious). | Disposal in safe landfills |
| Plastic bag | Black | <ul style="list-style-type: none"> • Discarded medicines • Cytotoxic drugs • Chemical waste • Incineration ash | Disposal in protected landfills |
| Plastic bag/ perforation proof container | Blue/ White/ Clear | <ul style="list-style-type: none"> • Sharp waste • Solid waste | <ul style="list-style-type: none"> • Shredding • Obliteration treatment |

3.1.2 Collection and storage of clinical waste

Hospital Waste Management Rules, 2005 provides for the inner gathering of full waste containers and bags to main collection part in the hospital. In Gujranwala city, after the segregation of clinical waste it is collected by a hygienic worker particularly allocated for this task (Ikram *et al.*, 2010).

Table 3: Collection and Storage practices in different cities of Pakistan (Khan *et al.*, 2019; Rasheed *et al.*, 2005; Janjua *et al.*, 2010; Ali *et al.*, 2017; Munir *et al.*, 2014; Anwar *et al.*, 2013; Badar *et al.*, 2014).

| City | Practices |
|------------|--------------------------------------------------------------------------------------------------------------------------|
| Gujranwala | After the segregation of clinical waste, it is collected by the healthcare workers particularly allocated for this task. |
| Abbottabad | All hospitals studied were using plastic containers, cardboard cartons and metallic vessels for collection of waste. |
| Islamabad | All hospitals studied were using plastic containers, cardboard cartons and metallic vessels for collection of waste |
| Faisalabad | Polyethylene bags were being used for the assemblage of clinical waste in many healthcare facilities |
| Karachi | In many clinics, waste was gathered by hand and discarded at the collection area by the health staff. |
| Bahawalpur | Public sector hospitals are using suitable bags for transport of waste inside the hospital |
| Lahore | 65% of the hospital waste is being gathered in exposed bins |

In Abbottabad and Islamabad, all hospitals studied were using plastic containers, cardboard cartons and metallic vessels for collection of waste (Khan *et al.*, 2019). Ali *et al.* 2017 reported the use of polyethylene gears for the assemblage of clinical waste in many healthcare facilities in Faisalabad. In Karachi, sporadic hospitals use distinct vehicles for the assortment of waste and its transport to main storage unit. Some of them were using stretcher, wheelchairs or ambulance of the hospital. In some clinics, waste was gathered by hand and discarded at the collection area by the health staff (Rasheed *et al.*, 2005; Janjua *et al.*, 2010).

In Faisalabad, 65% of the hospital waste is being gathered in exposed bins (Anwar *et al.*, 2013). Waste is collected and transported three times a day by workers in open trolley in two main hospitals (Munir *et al.*, 2014). In Bahawalpur, public sector hospitals are using suitable bags for transport of waste inside the hospital and collection part for waste until disposal was existing in all communal sector hospitals and in private sector hospitals it was present in 66.6% hospitals (Badar *et al.*, 2014).

3.1.3 Transportation of clinical waste

Section 18 of Hospital Waste Management Rules, 2005 comprises five subcategories about waste transportation (Khan *et al.*, 2019a).

Table 4: Transportation practices of clinical waste in different cities of Pakistan (Anwar *et al.*, 2013; Kumar *et al.*, 2010; Arshad *et al.*, 2011; Kumar *et al.*, 2015; Ali *et al.*, 2016; Ali *et al.*, 2018; Zeeshan *et al.*, 2018; Khan *et al.*, 2019a).

| City | Practices |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gujranwala | By scavengers to the adjacent metropolitan vessels using donkey carts. |
| Peshawar | 40% of the hospitals in Peshawar transport hazardous waste discretely based on waste container type and color. |
| Islamabad | There was no suitable availability of trolleys and color-coded gears for waste transportation in many hospitals across Rawalpindi/Islamabad |
| Faisalabad | Waste was being transported via municipal conveyance in uncovered litterbins |
| Hyderabad | The transportation measures were not found in any of clinic. |
| Rawalpindi | Trolleys with hazardous and the non-hazardous waste were transported through the shared ways in the hospitals and were not even washed later in two major hospitals of Rawalpindi |
| Lahore | For on-spot transference diverse types of means were existing. Carts were commonly used |

Transport of waste was unsafe and is a chief issue in Faisalabad. Waste was being transported via municipal conveyance in uncovered litterbins (Anwar *et al.*, 2013). There was no suitable accessibility of trolleys and color-coded gears for waste transportation in many hospitals across Rawalpindi/Islamabad (Kumar *et al.*, 2010). For on-spot transference diverse types of means were existing. Carts were commonly used in Lahore (Arshad *et al.*, 2011). Trolleys with hazardous and the non-

hazardous waste collected were transported through the shared ways in the hospitals and were not even wash away later in two major hospitals of Rawalpindi (Kumar *et al.*, 2015).

Off-site transport of all-purpose waste at numerous hospitals in Gujranwala was carried out by scavengers to the adjacent metropolitan vessels using donkey wagons (Ali *et al.*, 2016; Ali *et al.*, 2018). 40% of the hospitals in Peshawar transported hazardous waste discretely based on waste container position (Zeeshan *et al.*, 2018). Contrasting big hospitals, the transportation in small clinics waste transportation is nearly zero;

there were no carriage measures found in any of clinic of Hyderabad (Khan *et al.*, 2019a).

3.1.4 Disposal and treatment of clinical waste

Section 20 of Hospital Waste Management Rules 2005, along with 11 sub-sections provide for the waste disposal procedure (Khan *et al.*, 2019a). In Pakistan, incineration, chemical/ mechanical decontaminations, microwave fumigations, autoclaving and landfill are mostly used for disposal of clinical waste (Asante *et al.*, 2014).

Table 5: Treatment of Clinical Waste in different cities of Pakistan (Khan *et al.*, 2019; Arshad *et al.*, 2011; Ahmed, 2011; Anwar *et al.*, 2013; Ahmed *et al.*, 2019; Mukhtar *et al.*, 2018; Amin *et al.*, 2013; Khan *et al.*, 2006; Khan *et al.*, 2019; Hossain *et al.*, 2011).

| City | Practices |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hyderabad | There was no incineration facility available for hazardous waste from small clinics; only one incineration plant was in working condition and employed for big hospitals of the metropolitan. |
| Islamabad | Sharp objects are usually burnt but one hospital was using municipal landfills to dispose it |
| Swat | Hospitals of Swat were inspected for clinical waste disposal. 2 out of 7 hospitals burn while remaining direct waste to landfill sites |
| Faisalabad | Burial is being used for clearance of clinical waste. Only 2 incinerators were working in Faisalabad city |
| Karachi | 5 hospitals out of 8 surveyed were using incineration, 2 of them were using land filling while 1 was practicing open dumping method in Karachi |
| Bahawalpur | The autoclaving and dumping were being used for the final disposal of the hazardous waste. Ultimate clearance of waste was not appropriate in all hospitals. There was no incinerator in Bahawalpur city. |
| Gujranwala | The medical waste was moved to a semi incessant stoker type incinerator which could decrease the waste to 75% by weight and 90% by volume without energy recapture |
| Lahore | Incineration was well-thought-out to be the final treatment method in 80% of hospitals |
| Peshawar | 80% of the tertiary care instruction hospitals in Peshawar (100% public vs. 57.1% private) had incinerators and 71.4% of them were working. Dumping of the clinical waste was carried in 86.67% of the hospitals, whereas in 13.3% it was seared in open atmosphere |
| Abbottabad | Public sector hospitals conduct incineration, but private hospitals favored waste burning on grounds of hospitals or dump it in municipal landfills |

In Islamabad, sharp objects are usually burnt but one hospital was using municipal landfills to dispose it (Khan *et al.*, 2019; Arshad *et al.*, 2011; Ahmed, 2011). Burial is being used for clearance of clinical waste in Faisalabad city which is damaging for subversive water. Only 2 incinerators were working in Faisalabad city (Anwar *et al.*, 2013). 7 hospitals of Swat were inspected for clinical waste disposal. 2 out of 7 hospitals burn while remaining direct waste to landfill sites (Ahmed *et al.*, 2019). Mukhtar *et al.* 2018 reported that 5 hospitals out of 8 surveyed were using incineration, 2 of them were using land filling while 1 was practicing open dumping method in Karachi (Mukhtar *et al.*, 2018).

In Peshawar, dumping of the clinical waste was carried in 86.67% of the hospitals, whereas in 13.3% it was seared in open atmosphere. Incineration was done in 33.3% of the hospitals but no appropriate capacity for removal of radioactive waste was existing. 33.34% of the hospitals reimbursed the pharmacological waste to its contractors (Amin *et al.*, 2013; Khan *et al.*, 2006). In Abbottabad, public sector hospitals conduct incineration, but private hospitals favored waste burning on grounds of hospitals or interring it in municipal landfills (Khan *et al.*, 2019; Hossain *et al.*, 2011). Surveyed clinics were no exemption and all of them unsafe waste management foundations were detected during the research in Hyderabad. Moreover, there was no incineration facility available for hazardous waste from minor clinics; only one incineration plant was in working condition and employed for big hospitals of the metropolitan. (Khan *et al.*, 2019a).

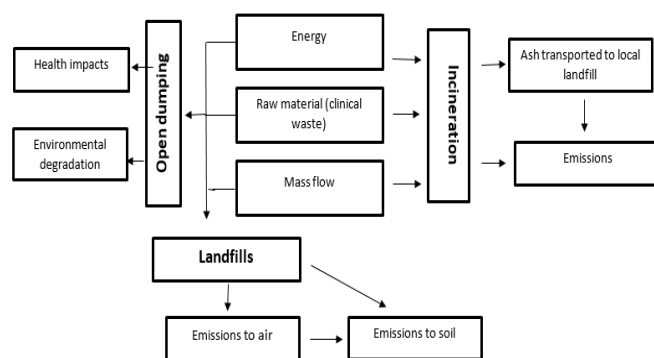


Figure 4: Flow chart of hospital waste treatment scenarios in Pakistan (Ahmed *et al.*, 2019; Soares *et al.*, 2013).

Kumar *et al.* 2010 testified that Overall waste assorted from each hospital was discarded along with metropolitan solid waste for additional disposal. The incinerator was existing and practical at only 1 government sector hospital but informed that waste was unsuitably deposited and treated for dumping in all the hospitals gaged (Kumar *et al.*, 2010). In Lahore incineration was well-thought-out to be the final treatment method in 80% of hospitals (Arshad *et al.*, 2011; Munir *et al.*, 2014; Ullah *et al.*, 2010). In Gujranwala the medical waste was moved to the incinerator in a semi incessant stoker type incinerator which could decrease the waste to 75%

by weight and 90% by volume without energy recapture (Ali *et al.*, 2016; Ali and Geng, 2018). 80% of the tertiary care instruction hospitals in Peshawar (100% public vs. 57.1% private) had incinerators and 71.4% of them were practical (Ullah *et al.*, 2010). In both hospitals, the autoclave

and incinerators were being used for the final disposal of the hazardous waste (Kumar *et al.*, 2015). Ultimate clearance of waste was not appropriate in all hospitals. There was no incinerator in Bahawalpur city (Badar *et al.*, 2014).

Table 6: Advantages and Disadvantages of Methods for Clinical Waste Treatment and Disposal Used in Pakistan.

| Treatment method | Description of the method | Advantages | Disadvantages | References |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Landfilling | Disposal of hospital waste to a dumping site with or without any treatment. | <ul style="list-style-type: none"> waste do not come across air, soil, and superficial water. Stops proclamation of harmful gases and bad smell into atmosphere. | <ul style="list-style-type: none"> can pollute underground water and land. restricted volume and life. | Ali <i>et al.</i> , 2012; Sui <i>et al.</i> , 2017; Debra and Philip, 2000; Habib <i>et al.</i> , 2013. |
| Autoclaving | In this method, wastes are sterilized or disinfected former to discarding in a landfill. | <ul style="list-style-type: none"> annihilation of germs. carries no standard health influences less costly Autoclave is effective for sterilizing | <ul style="list-style-type: none"> not appropriate, for pathological, cytotoxic, or other harmful chemical wastes aerosolizing of poisonous chemicals in the waste. not decrease the size of waste material | Mukhtar <i>et al.</i> , 2018; Ferdowsi <i>et al.</i> , 2013; Choudry <i>et al.</i> , 2004; Liu <i>et al.</i> , 2013 |
| Incineration | This is the procedure of scorching of waste in temperatures fluctuating from 982°C to 1093°C (1,800°F to 2,000°F). | <ul style="list-style-type: none"> quick, easy discarding process curtailing waste as it lessens the bulk by 20-30%. demolition of microbes. | <ul style="list-style-type: none"> emission apprehensions energy input prerequisite | Ferdowsi <i>et al.</i> , 2013; Klangsin and Anna, 2011; Mehmet <i>et al.</i> , 2009; Gautam <i>et al.</i> , 2010; Batterman <i>et al.</i> , 2004 |
| Open dumping or burning | Removal or burning of medical waste along with the municipal waste in order to get rid of it without any separation. | <ul style="list-style-type: none"> most low-priced and easy-going technique lessens the volume of waste. | <ul style="list-style-type: none"> Health apprehensions Aesthetic issues Leachate problems environmental pollution | Mukhtar <i>et al.</i> , 2018; Riaz and Butt, 2019; Nadeem, 2014. |
| Chemical disinfection | This procedure involves the use of biochemical agents for decontamination of solid wastes before disposal to landfill site. | <ul style="list-style-type: none"> obliteration of germs. less expensive | <ul style="list-style-type: none"> most suitable for liquid wastes kills microbes dropping health apprehensions. acidification possible, human poisonousness and eutrophication | Riaz and Butt, 2019; Ahmed <i>et al.</i> , 2019; Birpinar <i>et al.</i> , 2009; Omar <i>et al.</i> , 2012 |

3.2 Challenges to Safe Clinical Waste Management in Pakistan

Clinical waste is a possible health risk to health employees, community, vegetation and animals of the range. It has been recognized that, globally, around 5.2 million individuals (including 4 million kids) expire each year due to waste correlated ailments (Garba, 2013; Delmonico *et al.*, 2018). The threats of exposure to clinical waste can cause variety of diseases including gastrointestinal, respirational and skin disease and even lethal diseases like Hepatitis and AIDS (Akhtar, 2000; Yousaf *et al.*, 2019; Hassan *et al.*, 2015). Dangerous human well-being influences include carcinogenic effects together with reproductive and pulmonary reparations, nerval system damages, diarrhea, leptospirosis, typhoid and many others. Environmental irritation may also happen due to smells, pests, flies, insects and rodents (Nemathaga *et al.*, 2008; El-Salam, 2010).

Following are the challenges faced by developing countries especially Pakistan in the management of healthcare infectious waste (Ahmed *et al.*, 2019):

3.2.1 Poor Implementation Practices of Hospital Waste Management Rules 2005

Hospital Waste Management Rules (HWMR) were notified in 2005, under section 31 of Pakistan Environmental Protection Act, 1997. HWMR devised that the responsibility of waste management produced in the hospital lie on the hospital itself. Most of the hospitals in Pakistan are not complying with these rules due to poor implementation and lack of checks on them (Malik *et al.*, 2020; Ullah *et al.*, 2011). The hospital administrators are enormously ignoring the standards in clinical waste management and removal. This is an immense encounter as it has grave environmental repercussions (Rao *et al.*, 2016). They usually dump or burn the clinical waste (Anwar *et al.*, 2013). There is lack of cognizance of the administration concerning comprehensive laws and regulations overriding health care waste management. This boost reuse and unsanitary reprocessing of waste (Rasheed *et al.*, 2005). All the hospitals have established standards by EPA, but administration is not concerned in the execution of guidelines (Anwar *et al.*, 2013).

3.2.2 Lack of Training and Awareness of Staff Dealing with Clinical Waste

Many hospitals in Pakistan lag in providing basic protection equipment to staff members dealing with infectious waste. Poor education and training leads to incorrect handling, treatment, storage and disposal procedures (Yousaf *et al.*, 2020; Qadir *et al.*, 2014). Scavenging of the plastic from the hazardous waste is very dangerous and requires a harsh precautionary accomplishment (Awan *et al.*, 2017). Underprivileged segregation and

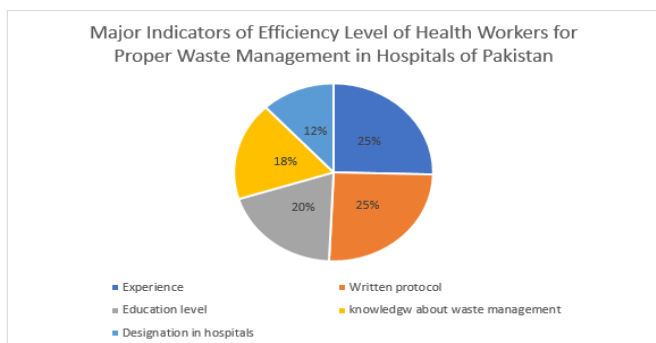


Figure 5: Major Indicators of Waste Management Staff Efficiency Level in Pakistan (Yousaf *et al.*, 2019; Mirzai *et al.*, 2016; Shafee *et al.*, 2010).

mingling of clinical waste with non-harmful waste and its disposal to metropolitan sites leads to many diseases amongst waste pickers (Batool and Anjum, 2016; Batool *et al.*, 2015). Waste segregation matters are due to absence of training drill of medical and additional staff including sweepers and ward employees (Kumar *et al.*, 2010).

3.2.3 Lack of Advanced Technology for Clinical Waste Treatment

The National Program for Prevention and Control of Hepatitis in 2006 relating 39 health accommodations of numerous stages, institute that 94% of the hospitals had no measures for solid clinical infectious waste managing services, 21% of them were not able to give the projected quantity of waste produced by them. A key inspection of Punjab health segment exposed that on paper procedures and measures were not accessible in any of the surveyed facility (Nishtar *et al.*, 2013). Satisfactory numbers of bag containers and vessels are not being given for the gathering and successive on-place stowage, of medical waste in the constituencies, hospitals, operational theatres and other parts everywhere waste is created (Shaner-McRae *et al.*, 2007; Babanyara *et al.*, 2013). Statistics displayed that up-to-date expertise in dumping of hospital waste is not being used in various hospitals in Pakistan (Anwar *et al.*, 2013; Ishtiaq *et al.*, 2018).

3.2.4 Weak Monitoring System and Poor Coordination

The administration and supervision of hospital waste is tremendously vital. The necessity for consistent consultations for refining the organization of communicable clinical waste is the need of hour. (Kumar *et al.*, 2015; Ikram *et al.*, 2010). Maximum hospitals in large municipalities of Pakistan illustrate the absence of supervision of practices amongst health authorities for disposal of waste (Yousaf *et al.*, 2020; Mahmood *et al.*, 2011). The incidence of therapeutic waste in all-purpose waste depicted a deficiency of execution of firm separation practices at numerous hospitals (Ali *et al.*, 2017).

3.2.5 Poor Waste Handling

Principally medical workforces and staff are deficient in appropriate seclusion and contamination regulating practices. For management of the possibly hazardous waste, only rare healthcare units provided that important protecting components are available to employees (Rasheed *et al.*, 2005; Hashmi and Shahab, 2003). Transference of waste inside hospital is also insecure. Hospice waste was being ecstatic in hospital in exposed garbage cans as a replacement for enclosed drums which was injurious for visitors and medical staff. Frequently hospitals do not have scheme in process to handle and treat the unsafe waste earlier to final disposal (Ali *et al.*, 2015; Babanyara *et al.*, 2013). Mostly hospitals have no distinct ways for medical waste conveyance (Ali *et al.*, 2017). Needle discarding containers were of cardboard, that could be the source of wound (Ali and Kuroiwa, 2009).

4. CONCLUSIONS

Clinical waste management in Pakistan is endorsed through proper legislation but unfortunately many implementation gaps have been identified in the studies conducted across the country. Many examples of better management can also be coated. Though, proper waste separation techniques, staff training regarding clinical waste management, and labeling, appropriate clearance and transport measures are not up to the mark. This review concludes that suitable infectious waste management is not being observed in view of national as well as international criteria. National institutions should be strong enough to keep an eye on malpractices. Health issues and environment pollution due to poor clinical waste management are evident in the recent years. Incinerator plants and waste to energy systems can be employed for better disposal. Public awareness and staff training should be the top priority of government for avoiding the issues highlighted in this review article.

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