EVALUATION OF HEALTH CARE WASTE MANAGEMENT IN SELECTED HEALTH FACILITIES IN KIAMBU COUNTY, KENYA

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Abstract

The international Convention on the Elimination of Persistent Organic Pollutants (POPs) lists medical waste incinerators among the main dioxin and furans sources in the environment. However, medical waste incinerators emit a wide range of pollutants besides dioxins and furans. These include heavy metals (lead, mercury and cadmium), fine dust particles, hydrogen chloride, sulphur dioxide, carbon monoxide, nitrogen oxides and other pollutants such as Products of Incomplete Combustion (PICs) into the atmosphere. The composition of health care waste generated can guide decisions on what disposal method is required for a particular health care facility. The purpose of this study was to evaluate health care waste management practices and compliance to the burn technology among the selected hospitals in Kiambu County, Kenya. Questionnaires were used for collecting information from respondents; analysis of heavy metal contaminants was done to ascertain the composition of the health care wastes. On the location of the incinerator, the study found that most of the burners were located close to areas inhabited by people, 62.5% of all being located near agricultural areas. 50% of all the burners were built near valleys and ridges which increased the dispersion area and health risk and few were built near wooded places (37.5%). Regarding the construction of the burner, the study found that 62.5% of the health centers studied had overhead shelter and protective enclosure for them. The study also found that only 50% of the health centers had constructed pits. The study further found that most common potential harmful chemicals that can be found around the health centre burners were emitted during combustion and the residual ash had a heavy component of metallic pollutants. A total of 10 (ten) health care facilities were selected. Bottom/fly ash samples were also collected from the burners/incinerators in the health care facilities visited.

Key words: Medical waste incinerators, location, construction, operation, heavy metals

1.0 Introduction

1.1 Study Area

The study was carried out in selected health care centers in Kiambu County. The County is located in central Kenya, geographical coordinates: 1° 10' 0" South, 36° 50' 0" East. It has a population of 1,623,282, which translates to 638 people per km^2 (GOK, 2009). Kiambu County has the following type of health Facilities: district hospitals (4), sub-district hospitals (3), dispensaries (108), health centers (29), medical clinics (170), nursing homes (9), maternity homes (1), others (22) according to KNBS (2009).

The following hospitals were purposively selected during the study:

(i). Naidu Hospital, Thika, Kiambu County, Kenya
(ii). Central Memorial Hospital, Thika, Kiambu County, Kenya
(iii). Thika District Level5 Hospital, Thika, Kiambu County, Kenya (a large referral hospital)
(iv). Mary helps the sick Hospital, Thika, Kiambu County, Kenya
(v). Kilimambogo Hospital, Thika, Kiambu County, Kenya
(vi). Mangu health centre l, Thika, Kiambu County, Kenya
(vii). Kalimoni Hospital, Juja, Kiambu County, Kenya
(viii). Jomo Kenyatta University of agriculture and technology Hospital, Juja,
(ix). Kiambu County, Kenya
(x). Gachororo Health centre, Juja, Kiambu County
(xi). Ruiru sub-District, Ruiru, Kiambu, Kenya

1.2 Health Care Waste

Health-care waste is a by-product of health care that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials. Poor management of health-care waste exposes health-care workers, waste handlers and the community to infections, toxic effects and injuries. It may also damage the environment. According to WHO, (2001), when this sort of waste is not managed properly, the healthcare service staff is exposed to contamination risk, occupational accidents and illnesses for being constantly exposed to microorganisms (Fiedler, 1998). Some examples of infections caused by exposure to infectious wastes are: gastro enteric, ocular, respiratory, skin and genital infections, anthrax, meningitis, acquired immunodeficiency syndrome (AIDS), hemorrhagic fevers, septicemia, bacteraemia, candidaemia and viral hepatitis A, B and C. Furthermore, other citizens such as companions, visitants, suppliers, volunteers and neighbors are also exposed to danger. Environmental problems may also arise due to foul odors, flies, cockroaches, rodents and vermin (WHO, 1999).

1.3 Environmental Impact of Healthcare Waste

The problems caused by medical waste are rising particularly quickly in developing countries, where the amount of waste being generated is rising rapidly as health-care services in those states are expanded, while the technological and financial tools to ensure the waste is managed responsibly may not exist. Georgescu, (2011) reports that in health-care establishments where hazardous medical waste is incinerated, open burning and widespread deficiencies in the operation and management of small-scale medical waste incinerators result in incomplete waste destruction, inappropriate ash disposal and dioxins emissions, which can be even 40,000 times higher than emission limits set in international conventions.

1.4 Medical Burner/Incinerator Siting, Construction and Operation

Variations in medical waste incineration processes and other innovative technologies continue to appear. At present, controlled air incinerators are popular due to their relatively low (capital, operating and maintenance) cost and their ability to meet existing air standards with or without air pollution controls (Colin, 1998). The location of an incinerator can significantly affect dispersion of the plume from the chimney, which in turn affects ambient pollutants concentrations, deposition and exposure of workers and the community to the gaseous emissions. Best practices of siting incinerators have the goal of finding a location that minimizes potential risks to the public health and the environment (Environmental Protection Agency {EPA}, 1997). Adequate plans, drawings, and quality control are necessary to construct incinerators. Dimensional drawings, tolerances and material listsare necessary. A lack of adequate quality control in the construction phase results in incorrectly-built facilities, whereby shelters, protective enclosures, and pits have not been constructed in most sites (Taylor, 2003).

Proper design and operation of incinerators should achieve desired temperatures, residence times, and other conditions necessary to destroy pathogens, minimize emissions, avoid clinker formation and slugging of the ash (in the primary chamber), avoid refractory damage and minimize fuel consumption. Good combustion practice (GCP) should be followed to control dioxin and furan emissions (Brna and Kilgroe, 1989). A minimum residence time of one second in the combustion zone at the minimum combustion temperature specified in the design is generally considered adequate to provide high-efficiency incineration. The residence time is calculated from the point where most of the combustion has been completed and the incineration temperature has been fully developed. In multi- chamber incinerators, the residence time is calculated from the secondary burner(s) flame front. If air is introduced downstream of the burner flame front, residence time should also be calculated from the final air injection point (Taylor, 2003).

1.5 Health Issues due to Improper Medical Waste Management

Most of the health care facilitates in Kenya treat most of their hazardous health care waste stream by use of burn technologies, most of which are poorly maintained. Profiling the technologies used and medical waste segregation systems will allow interventions to avoid possible castrophic health effects on humans and the surrounding environment. Emissions of toxic and persistent compounds from incinerators may result in human exposure at levels associated with adverse health risks. Dioxins and Furans are some of the environmental pollutants emitted by incinerators. Metallic and other persistent organic pollutants (POPs) are also emitted and associated with adverse medical results to the environment (Francini *et al*, 2004).

The unsafe disposal of health-care waste (for example, contaminated syringes and needles) poses public health risks. Contaminated needles and syringes represent a particular threat as the failure to dispose of them safely may lead to dangerous recycling and repackaging which lead to unsafe reuse. Long-term, low-level exposure of humans to dioxins and furans may lead to the impairment of the immune system, the impairment of the development of the nervous system, the endocrine system and the reproductive functions. Short-term, high-level exposure may result in skin lesions and altered liver function (Francini *et al,* 2004).

Exposure to dioxins has resulted in several types of cancer (Francini *et al*, 2004)... The management of health-care waste requires increased attention and diligence to avoid the substantial disease burden associated with poor practice, including exposure to infectious agents and toxic substances. Incinerators provide an interim solution especially for developing countries where options for waste disposal such as autoclave, shredder or microwave are limited.

1.6 Objectives

1.6.1 Main Objective

The main objective of the study is to evaluate healthcare waste management practices to assess compliance of non-burn and burn (incineration) technologies.

1.6.2 Specific Objectives

To profile the non-burn biomedical waste management practices in existence in health care facilities in selected hospitals in Kiambu County, Kenya, using questionnaires.

2.0 Methodology

The study utilized both the qualitative and quantitative approaches. Interviews were done among staff in charge of medical waste collection and disposal in each hospital. The questionnaires were completed at the study hospitals during the study. This was done with the help of the staff in charge of medical waste

collection and disposal. The assessment included a walk-around to identify all the medical waste, noting the color coding where applicable. Further assessments included quantifying the different waste generated and classifying it into sharps, infectious non-sharps and non-hazardous medical waste. The assessment also included visual studies of the burners/incinerators encountered their construction design and operational procedures. The competence, training and efficiency of the burners/incinerators operators were also assessed. Safety and handling procedures during collection and disposal of the biomedical waste were assessed by completion of questionnaire. Literature research was done to provide secondary data. Reports in the hospitals and various publications on the burners were used to provide secondary data.

2.1 Sampling

Ten hospitals were purposively selected within the area of Thika and Juja and the questionnaire was administered at each hospital.

3.0 Results and Discussion

A total of 10 hospitals were studied. All the hospitals are located in Kiambu County. Two of the hospitals were private, while three were catholic missionary health care facilities. The rest were government hospitals with one being a large referral hospital.

3.1 Location of Incinerator

The study first sought to establish the location of the burners/incinerators within the hospitals studied.

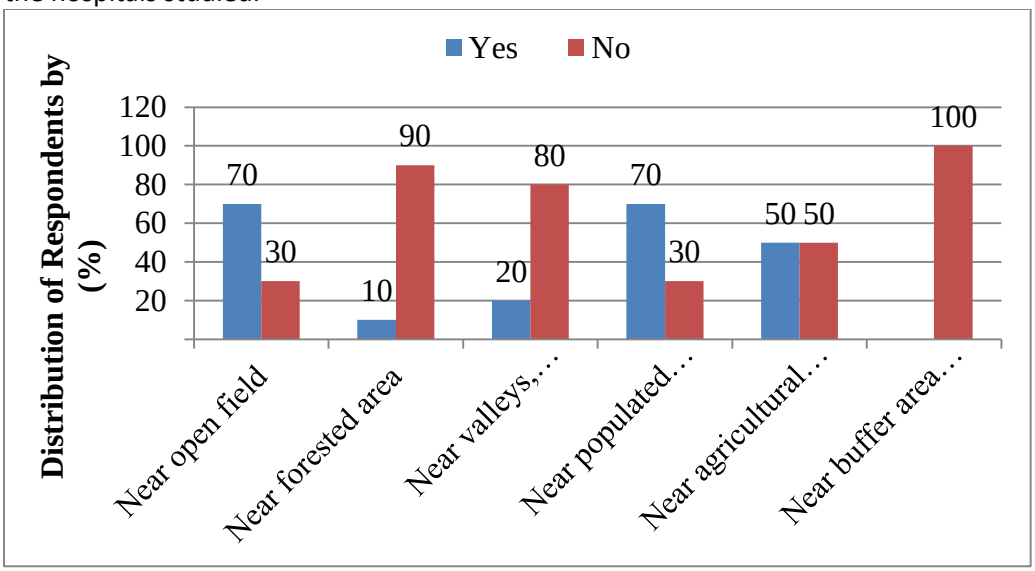

Figure 1: Location of Incinerator

Figure 1 shows that most of the burners/incinerators are located near an open field or hilltop without trees at 70%, near populated i.e. where people live and other social areas at 70% and near valleys, ridges and wooded places at 20%. According to Environmental Protection Agency (1997), the location of an incinerator can significantly affect dispersion of the plume from the chimney, which in turn affects ambient pollutants concentrations, deposition and exposures of workers and the community to the gaseous emissions. Best practices of siting incinerators have the goal of finding a location that minimizes potential risks to the public health and the environment.

3.2 The Adherence to Construction Standards of Burners/Incinerators

The study sought to find out whether the burners/incinerators had overhead shelter, protective enclosure and construction of pits. The findings are as presented in Figure 2.

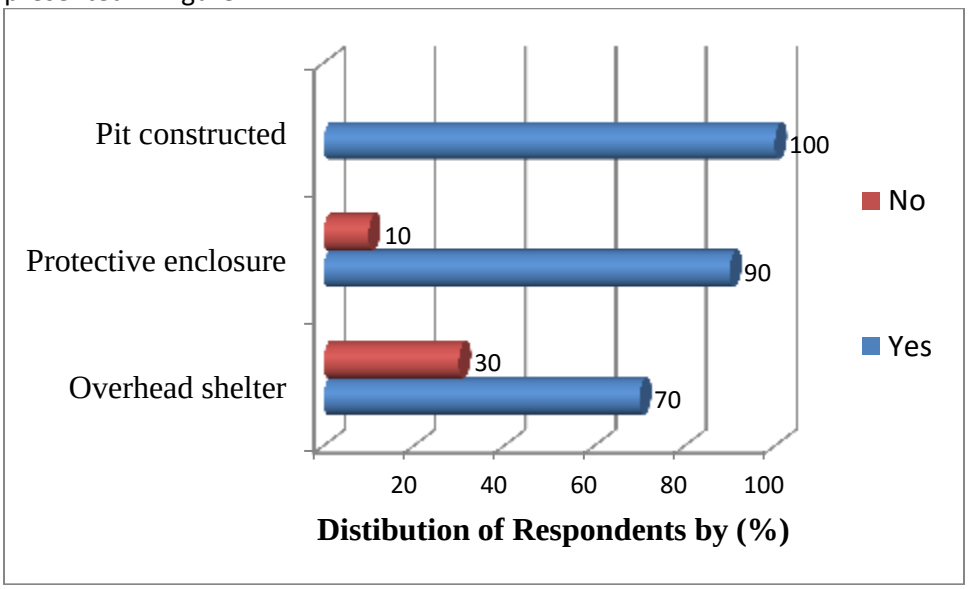

Figure 2: the adherence to construction standards of Burners/Incinerators

70% of the health centers studied had overhead shelter and protective enclosure at 90%. The study also found that all health care centers had constructed pits. It can therefore be said some incinerators/burner construction standards were not adhered to by the hospitals studied. According to Taylor (2003), a lack of adequate quality control in the construction phase results in incorrectly-built facilities. Shelters, protective enclosures, and pits had not been constructed at some sites. Most of the health centres did not comply with Environment Management Coordination Act (EMCA, 1999) waste management regulations especially Regulation 36, 37, 38 and 40 which specify and prescribe how all biomedical waste should be disposed. Regulation 40 ninth schedule lists how each waste should be

treated. According to the standards, Guidelines, Criteria, procedure for installing/operating incinerators in the EMCA act Waste management regulations 2006, the basic plant design must have four distinct sections that demonstrate three principles of turbulence; Residence time and temperature are inbuilt in the plant design. Few incinerators/burners had this basic plant design. The location of the incinerator/burner must be in accordance with the local county plan and be compatible with the premises in the neighborhood; it must also be housed in a suitably ventilated room.

3.4 Operation of Burner/Incinerator

On the operation of the burner/incinerator, the study sought to evaluate the processes of burner operation. The findings are presented in Figure 3.

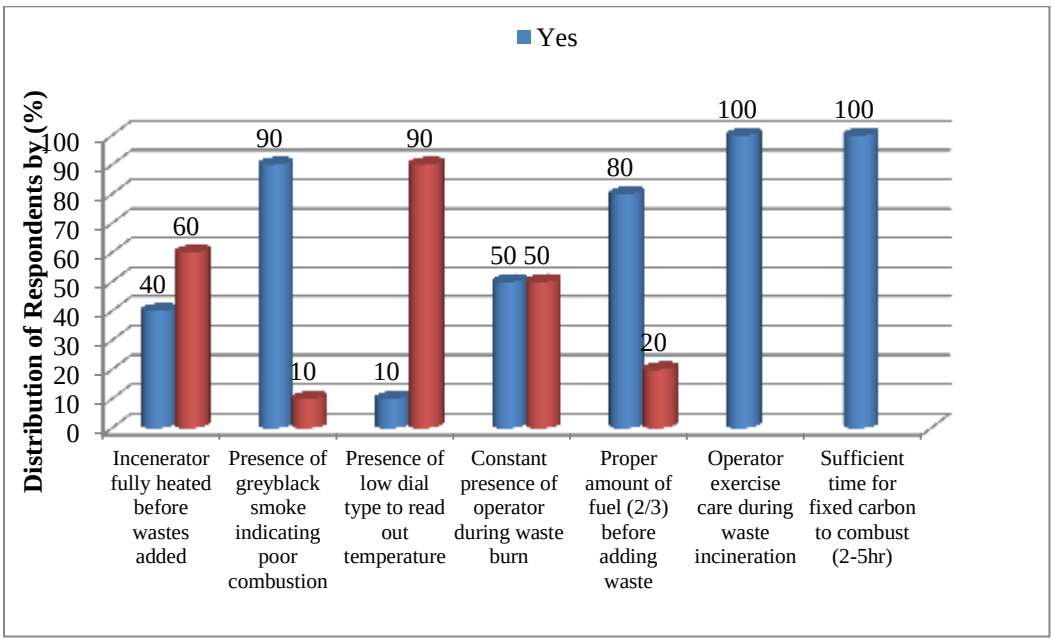

Figure 3: Operations of Burner/incinerator

As illustrated in Fig.3, 40% of the respondents indicated that they heated up the burners/incinerators before adding waste. The results revealed that low cost dial type to read out temperature was available to only 10% of the centers. The study further revealed that constant presence of the operator during the burn process was at adhered by 50% of the centers while all the operators at the health centers exercised care during waste incineration with a representation of 100%. The study showed that there was presence of black smoke indicating poor combustion in 90% of the health centers; this implied that safety considerations measures were not done in most of the centers. The study showed that most health care centers embraced best practices on burner/incinerator operations. From the findings, it

can be concluded that even though most centers embraced good operation methods; more of the operation standards were not met. According to Brna and Kilgroe (1989), proper design and operation of incinerators should achieve desired temperatures, residence times, and other conditions necessary to destroy pathogens, minimize emissions, avoid clinker formation and slugging of the ash (in the primary chamber), avoid refractory damage and minimize fuel consumption.

3.5 Monitoring During Operation

On the operation of the burner/incinerator, the study sought to evaluate monitoring processes of burner/incinerator operation. The operators answered some specific questions to describe the activities they encountered during operations. The findings are a presented in Figure 4.

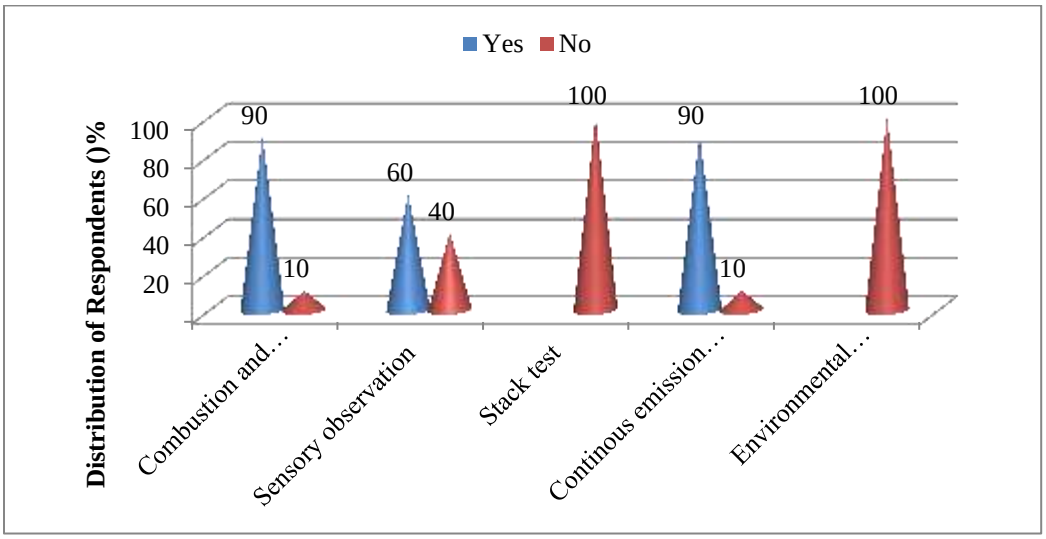

Figure4: Monitoring during Operation

The findings illustrated in Figure 4 indicate that most health care centers monitored combustion and emission to determine whether incinerators were properly operated at 90% while 10% of the centers did not carry out any monitoring on the operation. The study again revealed that sensory observation was adhered to by 60% of the respondents. However, 40% of the centers did not adhere to sensory operation. Good combustion practice (GCP) should be followed to control dioxins and furans emissions (Brna and Kilgroe, 1989). A study on a Spanish incinerator showed that stack gas emissions were only responsible for a minor contribution to the total dioxin emitted compared to amounts present in fly ash (Abad et al*.,* 2000).

3.6 Safety Considerations

The study sought to evaluate the safety considerations by the health centers during incineration. The findings are a presented in Figure 5.

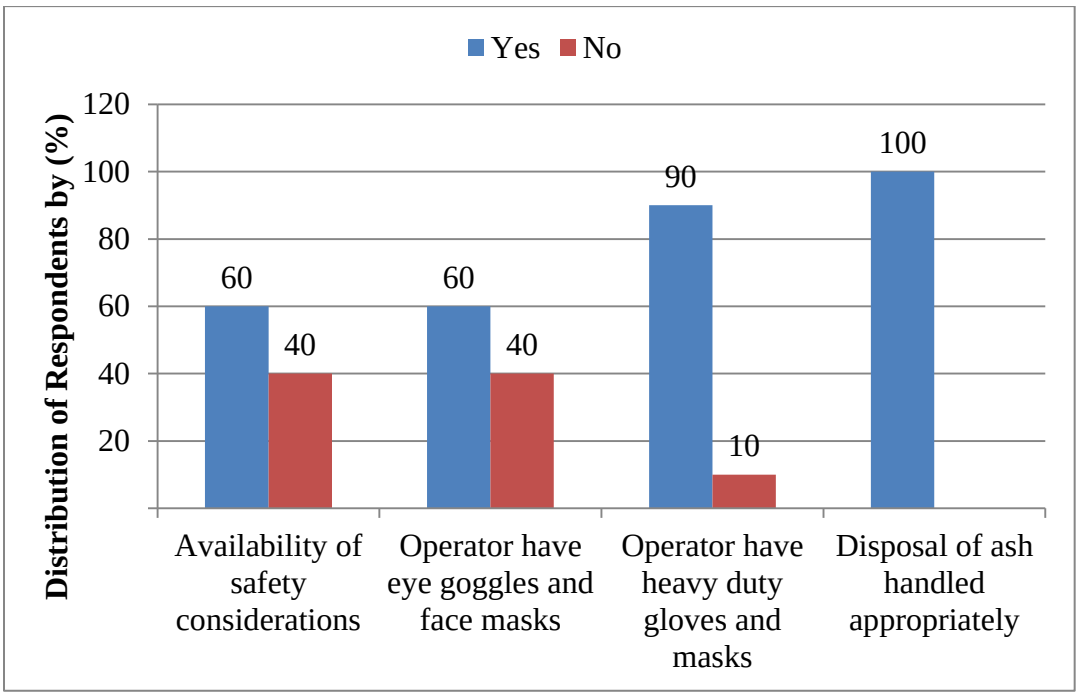

Figure 5: Safety Considerations

As illustrated in Figure 5, 60% of the respondents indicated that operators had eye goggles and face masks while 40% of the centers indicated that operators did not have eye goggles or face masks. Furthermore, the study indicated that all heath centers disposed ash appropriately. The findings could be interpreted to imply that most health centers adhered to safety precautionary measures to operate appropriately. According to Stairs and Johnston (1991), if further environmental degradation and harm of the operator is to be minimized and reversed, precaution and prevention must be the overriding principles of policy. The study hypothesized that upholding safety rules and regulations (wearing eye goggles, having heavy duty gloves, masks and disposing of ash appropriately) results to minimal exposure to harm during burner/incinerator operation

3.7 Maintenance of Incinerators

The study sought to determine whether there was proper incinerator maintenance for effective operation. The results are presented in Figure 6.

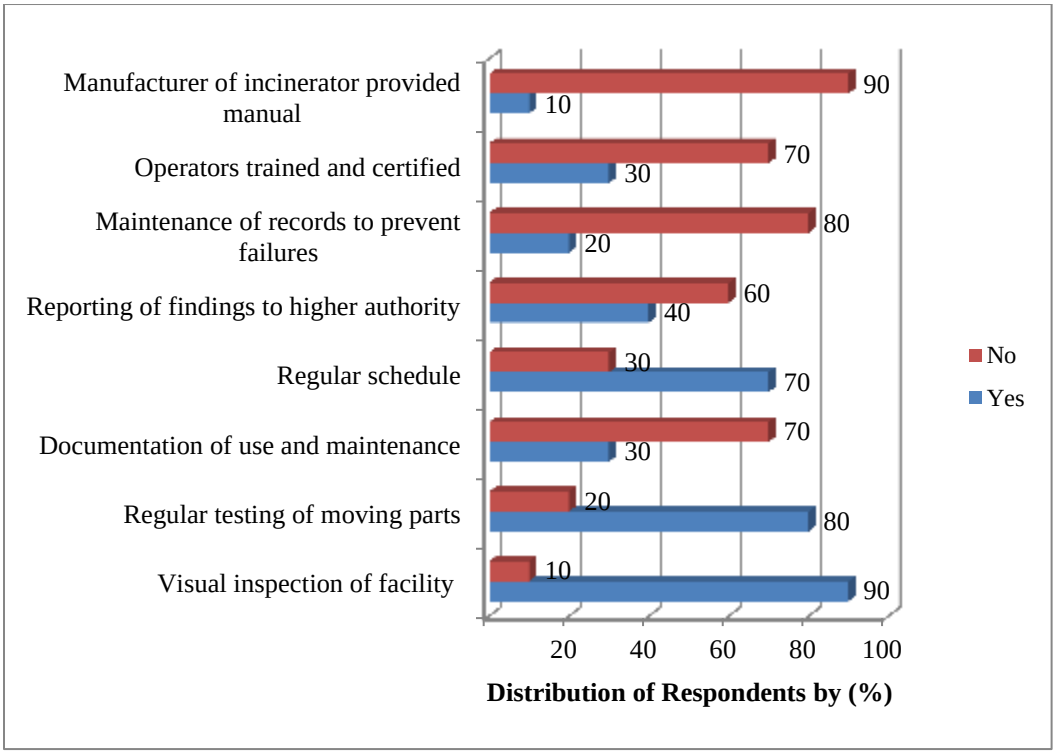

Figure 6: Maintenance of Incinerators

The results illustrated in Figure 4.6 showed that majority of the respondents (90%) did visual inspection of the facility to prevent corrosion, leaks, and mortar and seal failures. The study indicated that there was regular testing of moving parts by 80% of the respondents. On whether regular schedule was adhered to, 70% of the respondents indicated that indeed they regularly scheduled their operations. However, 60% of the respondents indicated that they did not report findings to higher authorities regularly. Again 80% of the health facilities indicated that they did not maintain records to prevent machine failures. The study also revealed that most operators were not trained and certified. The study finally revealed that manufacturers of incinerators did not provide operation and maintenance manual. The findings could be interpreted to mean that despite the fact that some health care centers upheld maintenance for effective and continuous operation, a considerable number however did not put much emphasis on the condition of their incinerators thereby jeopardizing the proper functionality of the machines.

The study hypothesized that visual inspection of the facility to prevent corrosion, leaks, mortar and seal failures, regular testing of moving parts, reporting findings to higher authorities regularly, maintaining records to prevent machine failures and provision of operation and maintenance manual reduces risk to operators hence conducive working environment.

4.0 Conclusion and Recommendation

4.1 Conclusion

From the findings of the study, it can be concluded that burners/incinerators in most hospitals studied were not located in the safe places. The study also concludes that all the health care centers had constructed disposal pits for the safe disposal of wastes to avoid exposing environment to hazardous effects during incineration. The study established that most hospitals did visual inspection of the facility to prevent corrosion, leaks, mortar and seal failures. On the maintenance of incinerators, the study indicated that there was regular testing of moving parts by most of the hospitals while a considerable number also asserted that indeed they regularly scheduled their operations for effective incineration and disposal of wastes.

The study further established that manufacturers of incinerators did not provide operation and maintenance manual thereby exposing the operators into risks due to lack of experience and guidelines. The study also concludes that the burners/incinerators in the hospitals studied were not constructed to the expected standards.

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