Incineration or Autoclave? A Comparative Study in Isfahan Hospitals Waste Management System (2010)

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ABSTRACT

Introduction: Medical wastes are among hazardous wastes and their disposal requires special methods prior to landfilling. Medical wastes are divided into infected and non-infected wastes and the infected wastes require treatment. Incineration is one of the oldest methods for treatment of medical wastes, but their usage have faced wide objections due to emission of hazardous gases such as CO2 and CO as well as Carcinogenic gases such as Dioxins and Furans which are generated as a result of incomplete combustion of compositions like PVCs. Autoclave is one the newest methods of medical wastes treatment which works based on wet disinfection.

Methods: The statistical population in this descriptive, comparative study includes hospitals located in Isfahan city and the sample hospitals were selected randomly. To environmentally evaluate the Autoclave method, TST (time, steam, temperature) and Spore tests were used. Also, samples were made from incinerator’s stack gases and their analyses results were compared with WHO standards. Findings: TST and spore tests results were negative in all cases indicating the success of treatment process. The comparison of incinerator’s stack gases with WHO standards showed the high concentration of CO in some samples indicating the incomplete combustion. Also, the incineration efficiency in some cases was less than 99.5 percent, which is the efficiency criterion according to the administrative regulations of wastes management law of Iran. No needle stick was observed in Autoclave method during the compaction of bags containing wastes, and the handlers were facing no danger in this respect. The comparison of costs indicated that despite higher capital investment for purchasing autoclave, its current costs (e.g. maintenance, etc) are much less than the incineration method.

Discussion: Totally, due to inappropriate operation of incinerators and lack of air pollution control devices, the use of incinerators doesn’t seem rational anymore. Yet, despite the inefficiency of autoclaves in treatment of bulky wastes such as Anatomical wastes, their usage seems logic considering the very low amounts of such wastes. Also, considering the amount of generated wastes in Isfahan hospitals, a combination of centralized and non-centralized autoclaves is recommended for treatment of infected wastes. Mobile autoclaves may also be considered according to technical and economical conditions. It must not be forgotten that the priority must be given to the establishment of waste management systems particularly to personnel training to produce less wastes and to well separate them.

Key words: Hospital Wastes, Infected wastes, Wastes Management, Incineration, Autoclave, TST Test, Spore Test.

1. INTRODUCTION

The disposal of medical wastes is an old problem in urban areas. The increasing growth of population has resulted in an increase in the number of patients and it has led to the increase of generated wastes. Hundreds of tones of hospital wastes are daily generated which require appropriate treatment and disposal. Since medical wastes are a source for contamination and pollution, capable of causing diseases and illness to human, special procedures are required for their treatment and disposal (1).

Medical wastes are divided into infected and non-infected wastes. Non infected wastes may be disposed by landfilling the same as municipal wastes (2). But the infected wastes require appropriate treatment processes prior to disposal. Currently, there are two main options for treatment of medical wastes in Iran (3): a) Incineration and moist heat treatment (autoclave); b) Medical wastes treatment means changing the nature of wastes into a non-infected or less infected condition prior to disposal (4).

Incineration is a process in which medical wastes burn and produce combustion gases and non combustible residues (ashes). Produced combustion gases are released to air directly or after treatment through air pollution control devices. The remained non combustible ashes are collected from incinerator and are lanfilled (5). The toxic ash residues sent to landfills for disposal have the potential to leach into groundwater. Medical waste has been identified by US Environmental Agency as the third largest known source of dioxin air emission (6). The air emis-
The collection of clinical waste samples and analysis were carried out in December 2008 to April 2010. The waste characterization study was carried out in accordance with WHO guidelines (WHO 1999; WHO 2001). All of the wastes generated in 5 hospitals were segregated and weighed during a period of 3 months, manually. The wastes from hospitals were collected from storage areas. The quantity and composition of the wastes were determined at each hospital. Along with the interviews, the physical compositions of waste in hospitals were determined. Before segregation, the wastes were spread by disinfectant solution (0.5% sodium hypochlorite). Masks and large forceps were used to segregate waste into several types. During segregation, each type of medical waste was discarded into bags. General and medical wastes from outpatient and inpatient services were collected separately. The medical wastes were previously sorted into various components such as serum, syringe and needle (in safety boxes), etc. Following these procedures, the wastes were transported to a special site for storage and final disposal.

To evaluate the efficiency of incinerator in “F” hospital, 20 samples were made from stack gases of incinerator using an IMR 2800. This device could measure up to 6 different gases and their temperatures at the same time. The treatment efficiency of the pre-vacuum autoclave in “A” hospital was evaluated using Class 6 TST Sterilization Indicating Strips and spore tests. TST test which is a chemical test was performed in every autoclave cycle. If the sensitive orange mark of the test changed into gray, the tests were acceptable. If the color was different, the test was repeated. If results were still unacceptable, then the spore test was performed. Spore test was done every 2 weeks or in emergency conditions. These purple tests contained Bacillus Stearothermophilus. After autoclave process, the tests were incubated for 48 hours in 60 °C. If the color did not change, the test was acceptable.

2.2. Data analysis
The quantities of hospital wastes were presented in terms of kg/day for total amount of waste generation. These data were used to determine the quantities of waste generated by each type of hospital. The data gathered from the questionnaire were compiled using statistical excel and SPSS. Also, the results obtained for costs were compared for two treatment options.

3. FINDINGS
The infected and non-infected wastes composition in selected hospitals was characterized using WHO guidelines (WHO 1999; WHO 2001). All of the wastes generated in 5 hospitals were segregated and weighed during a period of 3 months, manually. The results for non-infected and infected wastes composition in Isfahan hospitals are shown in Figure 1 and Figure 2, respectively.

At the time of this study, in Isfahan, most of the hospitals did not have any facilities to treat their wastes. They collect their wastes and through a contracted agreement, the urban services organization of the municipality conducts these wastes out of the hospital every two days. These hospitals have a source separation system to separate the infected wastes from non-infected. Unfortunately, this organization performs no treatment on these wastes and buries them in a not well operated landfill.
Table 1. The comparison of costs for two treatment methods

|                      | Autoclave | Incineration |
|----------------------|-----------|--------------|
| The cost description | Cost (Rls) | Cost (Rls)   |
| Skilled labor        | 3,200,000/ (1 person) | 6,400,000/ (2 persons) |
| Maintenance          | 400,000/year (2 times/year) | 600,000/year (3 times/year) |
| Energy consumption   | 2,600,000/ month (water, gas, electricity) | 5,200,000/ month (water, gas, electricity) |
| Tests (chemical, biological) and special bags (monthly) | 300,000/ month | Tests (chemical, biological) and special bags (monthly) | |
| Required space cost  | 180,000,000 | Required space cost | 540,000,000 |
| Capital Investment   | 750,000,000 | Capital Investment | 250,000,000 |

Table 2. The comparison of costs for two treatment methods

4. CONCLUSION

Comparing the medical, infected and non-infected wastes per capita rate in Isfahan with WHO standards, it is seen that the medical waste generation in Isfahan is higher than its standard value for east Mediterranean countries according to the WHO standard (Figure 5). In Isfahan, 40% of wastes are infected which is 15 to 20% higher than WHO standards. According to WHO standards, the amount of non infected wastes in east Mediterranean countries is 75 to 89% of total medical wastes (14).
According to results obtained and considering the current situation of medical wastes management in Isfahan, following recommendations are made: a) Primarily, like any integrated waste management system, it is recommended to try to reduce the amount of waste generated using appropriate methods to reduce the wastes disposal costs; b) High percentage of infected wastes indicates the inappropriate waste segregation processes and the lack of knowledge among personnel in this respect. Thus, conduction of training courses for personnel in charge is of great importance; c) Workplace health policies must be implemented and epidemiological studies must be conducted to determine the risks workforces are facing with; d) Financial liabilities must be allocated for integrated medical wastes management and to support internal producers of such facilities.; e) More studies on modern treatment systems and localizing them must be conducted, and separate studies on treatment of hospital wastewaters are required to perform.

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