



# Performance evaluation of non-incineration treatment facilities for disinfection of medical infectious and sharps wastes in educational hospitals of Shahid Beheshti University of Medical Sciences in 2013

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## Abstract

**Background:** In 2007, a rule prohibiting the use of incinerators was ratified by the Iranian Islamic Parliament. Based on this rule, the Ministry of Health emphasized the sterilization of infectious waste at its production source by means of non-incineration equipment and methods. This research examined the performance of non-incineration technologies in treating medical infectious and sharps wastes at educational hospitals affiliated with Shahid Beheshti University of Medical Sciences.

**Methods:** This cross-sectional descriptive study was conducted in 12 educational hospitals of Shahid Beheshti University of Medical Sciences. First, a questionnaire was designed and its validity approved. Then the required data was gathered during visits to participating hospitals. Finally, the collected data were analyzed using Microsoft Excel and SPSS version 16.

**Results:** Findings showed that the daily production of infectious and sharps wastes in the studied hospitals generally equaled 3387 kg. All hospitals were equipped with non-incineration systems; however, only 83.3% of them were active. Some infectious waste was disposed of along with urban wastes without being sterilized. Monthly biological assessments of treatment equipment were implemented for only 41.7% of the equipment.

**Conclusion:** The failures of the non-incineration systems demand that appropriate investigations be conducted prior to the purchase of these devices. Monthly biological assessments are essential to ensure the accuracy of the systems' performance in hospitals.

**Keywords:** Waste treatment, Non-incineration technologies, Infectious waste, Sharps waste, Hospital

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## Introduction

Over the last several decades, huge amounts of different kinds of waste have been produced by human activities and alterations in man's lifestyle and consumption patterns (1). Medical sciences are among the world's top advanced professional sections. While providing medical services, hospitals and healthcare facilities produce wastes, including body parts and tissue, sharp items, and other types of infectious waste, which are hazardous to the environment and to health (2). Hospital wastes can be divided into 2 categories based on their potential hazards and risks: non-hazardous wastes (quasi-municipal wastes), which include about 75% to 90%, and hazardous wastes which make up the remaining 10% to 25% of total clinical solid wastes (3). Based on World Health Organization (WHO) investigations, 80% of clinical solid wastes in developing

countries can be identified as non-hazardous wastes and can be treated just like other municipal wastes. The rest of these clinical wastes are comprised of infectious and pathological waste (15%), sharps waste (1%), chemical and pharmaceutical waste (3%), and other kinds of hazardous waste (up to 1%), like radioactive and cytotoxic wastes, broken thermometers, etc. However, a World Bank report stated that the current proportions of hospital wastes produced in Iran are contrary with those of other developing countries; in the other words, about 75% of hospital waste in Iran should be identified as hazardous and only 25% as non-hazardous (4).

Even though contemporary waste classification differs from that of 5 or 10 years ago, it still goes hand in hand with the advancement of treatment methods. Therefore, meeting the medicinal solid waste manual's requirements



is essential to ensuring occupational safety and public and environmental health. Environmental and public health specialists recognized the importance of infectious waste management long ago (5).

Disregard for standards in the collection, storage, conveyance, and disposal of hospital wastes can challenge the country with serious teething troubles in their public health and environmental programs (6,7). One estimate shows that approximately 5.2 million people globally (including 4 million children) die each year from waste-related diseases (8). Furthermore, according to WHO estimates in 2002, 23 million people in the world have acquired infectious diseases such as Hepatitis B (20 million people), hepatitis C (2 million), and AIDS (260 000 people) from contact with hospital waste (9). Epidemiological studies have also identified the risk of acquiring infectious diseases like hepatitis B (30%), hepatitis C (1.8%), and AIDS (0.3%) for people who have contact with sharp needles (10). Hospitals, as one of the most prodigious clinical waste producers in Iran, produce 400 tons of clinical wastes a day. However, according to official statistics from the Ministry of Health, 236 hospitals from a total of 875 hospitals in the country are not equipped with clinical waste treatment facilities (11). Falahzadeh et al (12) reported in 2012 that 31% of non-incineration treatment facilities in Yazd hospitals were used in source production. Bioudaghi et al (13) reported in 2011 that 31% of non-incineration treatment facilities in Mazandaran hospitals were used in source production. In 2010, Babai et al (14) studied 5 hospitals of Shahid Beheshti University of Medical Sciences. They reported 80% of them performed the disinfection, cleaning, and elimination of hazardous waste in accordance with the regulations. In their 2004 study in Korea, Jang et al (15) showed that 10% of wastes were treated with incinerators and autoclaves.

Any imperfection in management and disposal of clinical waste can lead to severe health and environmental problems; the best standard methods for managing hospital waste should be used (11). This study examined the performance of non-incineration technology for the management of waste in educational hospitals affiliated with Shahid Beheshti University of Medical Sciences.

## Methods

The population of this cross-sectional descriptive study comprised educational hospitals of Shahid Beheshti University of Medical Sciences. Sampling was performed using a complete census. Data were gathered from field investigations, observations, and interviews using an integrated questionnaire designed and validated for data collection. This questionnaire contained 198 questions in 4 categories of common information: disinfection related personnel status, disinfection, and the position of disinfection, treatment and disposal apparatus. This study proposes some appropriate applicable strategies based on the results. Trends for assessing the performance of non-

incineration disinfection apparatus used to treat infectious and sharps wastes in the studied hospitals were investigated. Data were analyzed using Microsoft Excel and SPSS version 16.

## Results

This study was implemented in 2013 in 12 hospitals affiliated with Shahid Beheshti University of Medical Sciences in Tehran composed of general hospitals (25%), specialty hospitals (8.3%), advanced specialty hospitals (41.7%), and specialty-advanced specialty hospitals (25%). Investigations showed that 25% of the hospitals achieved a first grade of excellence score and 75% of them acquired a first grade score. In the 12 studied hospitals, in only 66.7% of situations were produced wastes weighed accurately; the weight of the remaining 33.3% of the wastes were inferred from container volume. Average daily production of solid wastes equaled 9516 kg of non-hazardous waste, 3090 kg of infectious waste, and 297 kg of sharps waste. These hospitals had 3048 available beds, and the average amount of waste produced for each bed was 4.2 kg per day. The average amount of infectious waste produced was estimated to be around 1.11 kg per bed per day (Figure 1).

It is essential to segregate infectious waste from non-hazardous waste to prevent contamination of the latter. Findings showed that infectious waste was segregated from non-hazardous wastes in 100% of the studied hospitals, but not completely. Sometimes mixing and contamination occurred. The quality of segregation varied from excellent to very poor among hospitals. Two hospitals had a frequency percentage of 16.7%, so segregation was rated as excellent. Segregation at 3 hospitals was rated good with a frequency percentage of 25%, intermediate at three hospitals with a frequency percentage of 25%, and poor at one hospital with a frequency percentage of 8.3%. Three other hospitals received ratings of very poor with a frequency percentage of 25% (Figure 2). Safety boxes were used to collect sharps waste; however, non-hazardous and infectious wastes were also observed in some of these safety boxes. The quality of segregation of sharps waste in the studied hospitals varied from excellent to very poor. It received a rating of excellent with a frequency percentage of 33.3% in four hospitals, a rating of good in 6 hospitals with a frequency percentage of 50%, a rating of poor in one hospital with a frequency percentage of 8.3%, and a

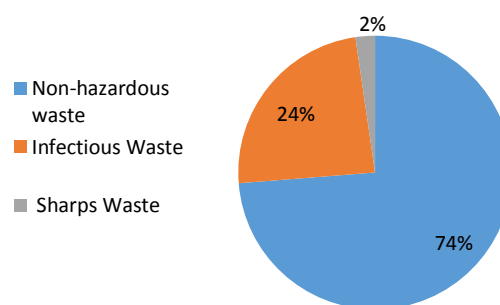


Figure 1. Frequency distribution of hospital waste.

rating of very poor in one hospital with a frequency percentage of 8.3% (Figure 3).

Findings showed that all studied hospitals were equipped with non-incineration disinfection facilities. In 11 (91.7%) of the 12 studied hospitals, the apparatuses were installed. The remaining hospital (8.3%) used a non-incineration disinfection apparatus which belonged to a private company. Eleven hospitals (91.7%) used thermal disinfection methods, and one hospital used a chemical disinfection method. Among the first 11 hospitals, 7 (63.6%) used autoclaves, 3 (27.3%) used hydroclaves, and 1 (9.1%) used the dry-heat sterilization method.

As shown in Table 1, among the 15 apparatuses installed in 12 hospitals, 12 devices (80%) were active and 3 others (20%) were not. In other words, 9 autoclaves (60%), 3 hydroclaves (20%), 2 dry-heat sterilization apparatuses were installed, and 1 hospital (6.7%) was using a chemical disinfection method. Among the 9 autoclaves, 6 (66.7%) were active and 3 others (33.3%) were not.

An investigation of each facility's failure rate in 2013 revealed that 21.4% had more than 5 instances of failure per year, 7.1% had 4 failures per year, 21.4% had 3 failures per year, 21.4% had just 1 instance of failure per year, and 28.6% of the apparatuses had no failures (Figure 4).

To examine the performance of disinfection operations, the hospital waste management manual states it is necessary for hospitals to perform chemical tests in every cycle for autoclave apparatuses and biological tests by means of *Bacillus stearothermophilus* or *Bacillus subtilis* vials for thermal and chemical methods every month. Among the 6 active autoclaves, 1 apparatus (16.7%) had never had chemical assessments, 3 (50%) had some chemical assess-

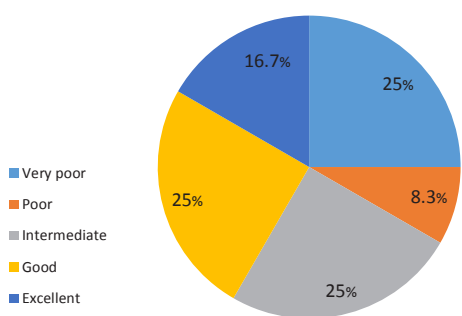
ments, but not for every cycle, and 2 apparatuses (33.3%) were chemically assessed every cycle (Figure 5). Two apparatuses (16.7%) had no biological assessment, 5 (41.7%) had some biological assessments, but not every month, and 5 (41.7%) were biologically tested every month (Figure 6).

**Discussion**

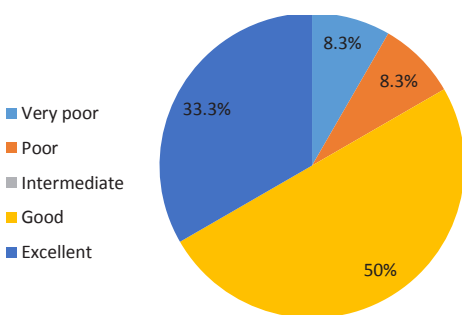
The importance of environmental conservation and urban population health requires that infectious wastes from hospitals and other healthcare sectors be disposed of separately from municipal wastes. Furthermore, it is essential

**Table 1.** Activity status of the disinfection apparatuses in studied hospitals

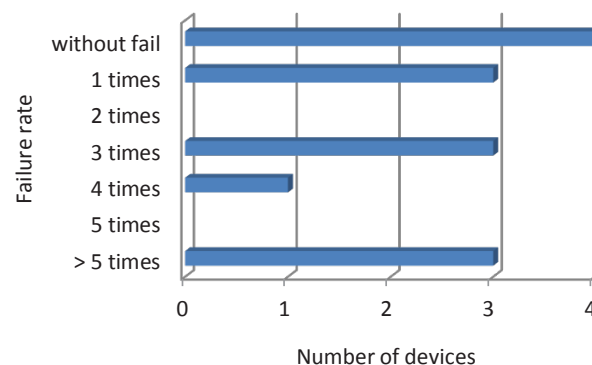
Hospital name	No. of installed apparatus	No. of active apparatus	No. of inert apparatus
Taleghani	1	1	-
Shahid Modares	1	1	-
Shohada e Tajrish	1		1
Koodakan e Mofid	1	1	-
Imam Housein	2	1	1
Akhtar	1	1	-
Panzdah e Khordad	1	1	-
Labafai Nejad	2	2	-
Mahdieh	1		1
Loghman e Hakim	1	1	-
Tarfeh	1	1	-
Masih e Daneshvari	2	2	-



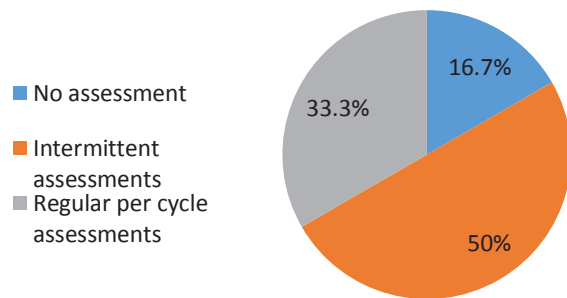
**Figure 2.** Infectious waste quality of segregation ratings.



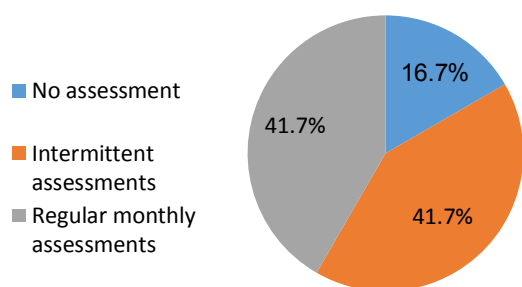
**Figure 3.** Sharps waste quality of segregation ratings.



**Figure 4.** Failure rate of disinfection facilities in studied hospitals.



**Figure 5.** Status of chemical assessments of active autoclaves.



**Figure 1.** Status of biological testing for all active disinfection facilities

that these wastes be disinfected prior to being discharged into the environment. If these wastes find their way into municipal waste disposal or recycle areas, they can cause serious problems.

The amount of infectious and sharps wastes in the studied hospitals equaled about 35.6% of total produced waste, which is much more than that predicted by WHO. Segregation of these wastes at the point of production should be controlled wisely. Non-hazardous wastes, like syringes and paper, and chemical wastes, like serum bottles, were observed in an infectious waste container, and blood-stained gauzes were found in safety boxes. Farzadkia et al (16) reported 51.4% of 5 hospitals in Tehran produced waste, and Falahzadeh et al (12) reported this 46.7% of 20 hospitals in Yazd. In Pakistan in the years 2004-2006, the amount of waste generated was determined to be 2 kg per bed per day, and 0.5 kg of that was hazardous waste (17). Only 83.3% of the disinfection sets were active; 16.7% of them were inactive because of the high costs of repair and part replacement in addition to inappropriate application and interference by untrained personnel. The report conducted by Health Care Without Harm (HCWH) in 2010 on the successful implementation of waste disinfecting in a hospital in Tanzania showed that from October 2008 to reduce the risks of autoclaves and crushers waste before disposal is used (18). The findings of Majlesi (19) showed that, at that time, none of the hospitals had been equipped with disinfection facilities. The current study found that hospitals affiliated with Shahid Beheshti University of Medical Sciences have made marked advancements since 2005; however, the inactivity of disinfection sets can lead to aggravated health problems, since infectious waste is being disposed of in municipal waste landfills without being disinfected and in combination with non-hazardous waste (quasi-municipal waste). Furthermore, the cost of conveying the infectious waste is being paid to the municipality, which is not economical. A serious problem exists because of the inactivity of these devices. The most adverse limitations of such apparatuses include a high annual failure rate and high repair and part replacement costs. The best way to assess the performance of disinfection is through monthly biological tests. Results from this study showed that monthly biological tests were imple-

mented regularly for 41.7% of the apparatuses, while for another 41.7% of them, testing occurred intermittently. The remaining 16.7% had no biological testing done. The findings of Aghapour et al (20) in their study of 39 Tehran hospitals showed that biological tests were implemented in 45.45% of the sets, but the other 54.55% of the apparatuses had no biological testing performed (20). If all steps of waste management are executed wisely and different stages of the set operation observed but no biological testing is done, assessing device performance is impossible. Moreover, if the operation is not performed perfectly, the release of infectious waste into the environment will lead to serious environmental and health problems.

### Conclusion

According to results of the current study, some suggestions and guidelines are proposed: (a) Employees involved in the disinfection process should be informed about special wastes; (b) Medical waste management training should be implemented for healthcare managers, nurses, and physicians to inform them about different kinds of wastes and how to segregate them at the point of production; (c) Monthly biological assessments of the disinfection sets should be performed; (d) Regular assessments of the sets should be scheduled and their failure prevented by the hospitals; (e) The producers or importers of the apparatuses should be obliged to execute periodic technical inspections and provide technical information about the devices application, installation, and biological assessment.

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### Ethical issues

This study was carried out in educational hospitals affiliated with Shahid Beheshti University of Medical Sciences, Iran. The authors certify that all data collected during this study is presented in this manuscript, and no data from this study has been or will be published separately.

### Competing interests

The authors declare they have no competing interests.

### Authors' contributions

All authors were involved in study design, data collection, and article approval.

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