Waste Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Health Care Waste generation rates and patterns: The case of Lebanon

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ARTICLE INFO

Article history:
Received 22 October 2014
Accepted 5 May 2015
Available online xxxx

Keywords:
Health Care Waste
Generation rate
Infectious Health Care Waste
Waste management

ABSTRACT

The objective of this study is to analyze Infectious Health Care Waste generation rates and patterns in Lebanon. Therefore, the quantities generated during five years by 57 hospitals from a total of 163 in the country have been analyzed. The seasonal evolution of Infectious Health Care Waste production and the evolution of the evaluation of the trends over years have been studied. Besides, the generation per capita have been estimated and compared to other countries. The variance between categories and the correlation between number of beds and Infectious Health Care Waste generation have been analyzed. The obtained results showed that the large private hospitals (over 200 beds) are characterized by their high generation rate: an average of 2.45 kg per occupied bed^{-1} day^{-1}, whereas the average generation rate for other categories is 0.94 kg per occupied bed^{-1} day^{-1}. The weighted mean is 1.14 per occupied kg bed^{-1} day^{-1}. Small public hospitals (i.e. less than 100 beds) have the smallest standard deviation: 0.13, whereas large private hospitals (i.e. over than 200 beds) have the highest standard deviation: 0.40. Infectious Health Care Waste generation has been estimated to 1.42 kg/capita/year.

The correlation between the numbers of hospitals beds in hospitals and the generation rate per bed is weak. The correlation between Infectious Health Care Waste generation per day and beds number is stronger. The total quantity produced by hospitals has increased over the five past years. These results suggest that the quantities of medical waste are not well controlled, and that hospitals have a defective monitoring management system of their waste. Annual peaks are observed in June, July, and December. Thus, this study, for the first time in Lebanon, has provided information on the infectious waste generation, allowing benchmarking between hospitals and between countries.

1. Introduction

Health Care Waste (HCW) includes all the waste generated by hospitals, private surgeries, other health care facilities, diagnostic centres, research facilities and laboratories and dental practices (Marinković et al., 2008; Graikos et al., 2010; Voudrias and Graikos, 2014).

HCW management is an imperative environmental and public safety issue, due to its potentially infectious and/or toxic character (Jang et al., 2006; Tsakona et al., 2007; Ferreira and Teixeira, 2010; Graikos et al., 2010). HCW can be divided into two major categories: general waste which represents 80% of total HCW; and Hazardous Health Care Waste (HHCW) which represent 20% of total HCW (WHO, 2011; Voudrias and Graikos, 2014). Explicitly, HHCW includes Infectious Health Care Waste (IHCW), and other HHCW which includes different categories: chemicals, pharmaceuticals, genotoxic waste, and radioactive waste. Infectious Health Care Waste (IHCW) is the waste type suspected to contain pathogens (bacteria, viruses, parasites or fungi), in sufficient concentration or quantity to cause disease in susceptible hosts (Pruss et al., 1999). Thus, IHCW management is a particularly high priority environmental concern, because inappropriate management of this type of waste may cause damage to human through injury by sharp instruments, infectious diseases such as HIV infection and hepatitis transmitted to humans due to proliferation of micro-organisms, environmental pollution and as well as contamination of ground water (Jang et al., 2006; Marinković et al., 2008; Yong et al., 2009; Graikos et al., 2010; Ferreira and Teixeira, 2010; Dursun et al., 2011).

Abbreviations: HCW, Health Care Waste; IHCW, Infectious Health Care Waste; HHCW, Hazardous Health Care Waste; WHO, World Health Organization.

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http://dx.doi.org/10.1016/j.wasman.2015.05.005
0956-053X/

HCW management is one of component reflecting the ability of hospital to provide a good standard of care (Sanida et al., 2010). Hospitals, particularly in developing countries, usually face difficulties in monitoring HCW management in a manner to avoid wrong practices, like inappropriate HCW sorting or disposing IHCW untreated and mixed with municipal waste in landfills (Tsakona et al., 2007; Diaz et al., 2008; Karagiannidis et al., 2010; Ferreira and Teixeira, 2010). The management of HCW requires source-separation of the hazardous fraction and sorting of this into infectious and toxic sub fractions (Graikos et al., 2010). Two potential problems can be commonly faced: first; some IHCW could be placed in the non-hazardous health care stream with potential hazard of spreading infection; then, not contaminated waste could be placed in the IHCW stream, thus making the volume of IHCW larger (Graikos et al., 2010). Thus, inappropriate sorting practices can lead to increased quantities of IHCW and hence higher costs of disposal (Tsakona et al., 2007; Ferreira and Teixeira, 2010).

Approximately 10–25% of HCW is considered infectious (UNEP, 2002; Diaz et al., 2008; Shinee et al., 2008). However, the percentage of IHCW in the total Health Care Waste stream in developing countries can reach 63% compared to 51% in an industrialized country (Diaz et al., 2008). The proportion can be reduced with appropriate sorting practices (UNEP, 2002).

Types of medical establishments and the waste management capacity at hospitals have been recognized as important factors in waste management (Cheng et al., 2009; Yong et al., 2009). In fact, data from the WHO show that the amount of HCW production depends on the size and the type of medical institution, but also it differs from country to country based on their national income or their level of development (Marinković et al., 2008). High developed countries have a larger production of medical waste than middle developed and developing countries (Marinković et al., 2008). The total amount of healthcare waste generated in a hospital in an industrialized country would be approximately 1.2 to more than 200 times that generated in some developing countries (Diaz et al., 2008). The difference in quantities results from the fact that developed countries invest much more money in health systems, leading to larger amounts of medical waste generation (Marinković et al., 2008).

IHCW generation rate is one of the principal elements reflecting sorting and other waste management practices. Many studies defining HCW generation rates in different countries have been reported in literature. For instance, the HHCW generation rates of large hospitals in Korea were found to vary from 0.14 to 0.49 kg bed^{-1} day^{-1} (Jang et al., 2006), assuming 100% bed occupancy. The average HHCW generation rate was around 0.25 kg bed^{-1} day^{-1} in Bangladesh (Patwary et al., 2009, 2011). In Iran, the average HHCW generation rate ranged from 0.4 to 1.91 kg bed^{-1} day^{-1} (Taghipour and Mosaferi, 2009). In Greece, an IHCW generation rate of 1.4 kg bed^{-1} day^{-1} was reported by Tsakona et al. (2007); and an average generation rate of 0.58 kg bed^{-1} day^{-1} or 0.87 kg occupied bed^{-1} day^{-1} was reported by Sanida et al. (2010). An average generation rate of 0.54 kg bed^{-1} day^{-1} was reported in Taiwan (Cheng et al., 2009). The IHCW average rate was 0.34 kg bed^{-1} day^{-1} in Philippine; and 2.0 kg/bed-day in Portugal (Diaz et al., 2008). According to WHO (2011) East Asia, Eastern Europe and the Middle East produce 1.3 to 3 kg per bed.

Today, IHCW sorting is done at the point of generation in the majority of hospitals in Lebanon. Around 70% of produced IHCW is treated by shredding associated to autoclaving through a national network for IHCW management, operated by a Non-Governmental Organization (NGO), "arcenciel". This network provides training and awareness on HCW sorting and management for administrative staff, cleaning staff, and health care staff. Then, based on an assessment for the evaluation of IHCW generation and the availability and the capacity of refrigerated storage room within the hospital, a collection frequency is determined. arcenciel collects IHCW from hospitals on a regularly basis. IHCW is weighted in each hospital immediately before collection, in presence of one representative of the hospital, who signs the waste tracking document. IHCW is then transported to the nearest treatment centre of the network. The network includes five treatment centres covering all regions in Lebanon. Each treatment centre includes one autoclave for medical waste and can be a backup system for all other centres when needed. Every trimester, arcenciel sends reports to the Ministry of Environment, including the quantities collected from each hospital. Limited recent and reliable information is available in Lebanon on the quantities of the various types of wastes that are generated in healthcare facilities. Thus, hospitals and governmental authorities lack reference data in order to evaluate IHCW sorting and management practices. Site-specific data related to the generation rate of IHCW are necessary for assessing environmental impact and designing management strategies (Graikos et al., 2010).

The objective of this study is to calculate the average generation of IHCW per different hospital categories in Lebanon; to analyze possible statistical differentiations among those categories; and to compare calculated generation rates with other available references. Then, we will analyze the chronological evolution of IHCW during past years. This study will facilitate benchmarking among hospitals and countries, by allowing them to compare their generation rates against other hospitals and countries, which will help them to identify possibilities of improving the efficiency of their waste management system and predict their waste management costs.

2. Material and methods

Lebanon has a total of 163 hospitals (i.e. 15,342 beds) spread throughout the country of which 135 (82.82%) fall under the private sector i.e. 12,648 beds (82.44%); and 28 (17.18%) under the public sector i.e. 2550 beds (16.62%) (IGSPS, 2012). Around 75% of hospitals have a bed capacity lower then hundred (IGSPS, 2012). Hospitals started progressively to treat their IHCW in 2003. Generally, according to the Lebanese decree 13389, is considered as IHCW in Lebanon (1) any waste material that came in contact with blood and other potentially infectious fluids of the body, (2) sharps, (3) any waste produced by an isolated patient and (4) biological fluids, small anatomic parts, tissues, cultures and stocks of infectious agents.

HCW quantities can be either assessed by direct measurements at the source, by the use of questionnaires, or by the direct use of hospitals weight records (Komilis et al., 2012).

In this study, quantities were assessed by the use of the monthly records of the NGO "arcenciel", a service provider for waste collection and treatment in Lebanon since 2003.

Thus, the study is based in records of the weights of IHCW bins collected and treated by the service provider for the years 2009, 2010, 2011, 2012 and 2013. The frequency of collection depends on IHCW generation and hospitals storage capacities. When small amounts of waste are generated, IHCW is stored in specific refrigerated rooms within hospitals until a greater amount of IHCW was generated over time, before proceeding with the collection. In fact, IHCW can be stored more than a week before treatment, provided that they are kept cool or refrigerated at a temperature preferably no higher than 3 °C to 8 °C (WHO, 2013). Bins were weighted in the presence of a representative of the hospital who signs at each collection a statement of the quantities. The quantities used in this study correspond to the monthly sum of IHCW collected per hospital, and sent every trimester by the service provider to the Ministry

Please cite this article in press as: Maamari, O., et al. Health Care Waste generation rates and patterns: The case of Lebanon. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.05.005