

# Medical Waste Management: A Case Study of the Souss-Massa-Drâa Region, Morocco

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## ABSTRACT

Medical waste management is of major concern due to the potentially high risks to both human health and the environment caused by inadequate waste management practices. In Morocco, as in many developing countries, little information is available regarding generation handling, and disposal of medical waste. The specific objective of this study was to analyse the medical waste management practices in the Souss-Massa-Drâa region, Morocco. The study was carried out in seven of the twelve hospitals in the region, covering 66.2% of the bed capacity. A total of 219 healthcare personnel and their assistants were included: 35 doctors, 98 nurses, and 86 housekeepers. Site visits, interviews, and survey questionnaires were implemented to collect information regarding different medical waste management aspects, including medical waste generation, separation, collection, storage, transportation, and disposal. The results indicated that the medical waste generation rate ranged from 0.4 to 0.7 Kg/bed-day with a weighted average of 0.53 Kg/bed-day. The percentage of infectious and hazardous wastes in the total medical waste stream was about 30.5%. The remaining 69.5% was general wastes similar in properties to municipal wastes. Concerning waste separation, housekeepers demonstrate a slightly higher knowledge about waste separation, with 49.4% of correct answers, with nurses at 45.7%, and doctors the lowest value at 38.6%. The results about other management aspects indicated that practices in most surveyed hospitals did not comply with the principles stated in Moroccan legislation. Based on the findings, some measures are suggested to improve the present conditions and ensure that potential health and environmental risks of medical waste are minimized.

**Keywords:** Environment; Health; Healthcare Personnel; Medical Waste; Morocco

## 1. Introduction

Medical wastes are of substantial importance due to their potential as environmental hazards and their risks to human health. This type of waste contains infectious waste, toxic chemicals and heavy metals, and may contain substances that are genotoxic or radioactive. Despite the fact that current medical waste management practices vary from hospital to hospital, the problematic areas are similar for all healthcare units and at all stages of management [1]. World Health Organization (WHO) in 2002 conducted an investigation survey on management of medical waste in 22 developing countries. Results showed that the proportion of healthcare facilities that did not use proper waste disposal methods ranged from 18% to 64% [2]. Improper management practice impacts both directly and/or indirectly the healthcare staffs, patients

and hospital environment [3,4]. It is of great importance to manage medical waste in a proper manner to avoid risks to both human health and the environment.

Good medical waste management in a hospital depends on a dedicated waste management team, good administration, careful planning, sound organization, underpinning legislation, adequate financing, and full participation by trained staff [5]. In addition some authors indicated the importance of other aspects, including the use of appropriate techniques for disposal [6,7], an internal management system and training program for related personnel [8,9], the waste generated [1], and a national regularly framework [10,11]. The medical waste management practice in Morocco is performed in accordance with the Medical Waste Management Decree No. 2-09-139 of 2009 [12]. Decree No. 2-09-139 establishes definitions, principles and the procedures for separation, collection, transportation, storage and disposal of medical

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waste. The medical wastes have been defined as any solid waste that results from the treatment, diagnosis, or immunization of humans and/or animals at hospitals, veterinary and health-related research facilities, and medical laboratories. Decree No. 2-09-139 also attributes specific responsibilities to the various sectors involved: generators, sanitation and environment. The Decree states that generators are mandated to properly manage medical waste.

In order to improve medical waste management and develop a management strategy for the Souss-Massa-Drâa region, it is important to understand and evaluate current practices in medical waste management. Information regarding medical waste management in this region is currently insufficient. The main objective of this study is to assess the current management practices of medical waste in hospitals of the Souss-Massa-Drâa region. Medical waste management was surveyed by gathering information regarding medical waste generation, separation, collection, storage, transportation, and disposal. Additionally, some measures are suggested to improve the present conditions and solve the identified problems.

## 2. Materials & Methods

This study was performed from September 2012 to January 2013, in seven of the twelve hospitals in the Souss-Massa-Drâa region, Morocco. The seven hospitals contain 1548 beds, corresponding to 66.2% of the region's total bed capacity. The studied hospitals provide general medical, surgical, pediatric, maternity, and a range of specialist services.

Site visits, interviews, and survey questionnaires were implemented to collect information regarding different medical waste management aspects, including medical waste generation, separation, collection, storage, transportation, and disposal. During site visits, observation checklists were used based on Moroccan legislation and guided by the literature [13-18]. To support and supplement information collected during site visits, interviews were conducted with the managers responsible for environmental management, and the personnel involved in the collection and handling of medical wastes in each hospital.

The questionnaires were formulated to evaluate the knowledge and waste management practices of doctors, nurses, and housekeepers. Questionnaires were distributed to various departments in each hospital. Confidentiality was ensured and all forms were anonymous. The questionnaires involved 25 items that covered areas of medical waste management. At the end of this survey, 219 questionnaires were valid (the response rate was 75.5%). Data from the questionnaires were stored and coded in a database for subsequent analysis. The data

were checked for consistency and completeness, and then statistically analysed using Epi-info Software.

## 3. Results and Discussion

In order to develop proper waste management strategies, it is important to have accurate information on the medical waste generation rate. Results from the survey suggested that the average generation rate of medical waste produced at the seven hospitals is between 0.4 and 0.7 Kg/bed-day with a weighted average of 0.53 Kg/bed-day. These results were compared with generation rates determined in other studies from different countries. In the study performed in the Sylhet city in Bangladesh, the average generation rate of medical wastes was about 0.934 Kg/bed-day [19]. A study conducted by Abdulla *et al.* (2008) indicated that the weighted average generation rate was 0.83 Kg/bed-day in northern Jordan. Abd El-Salam (2010) reported an average generation in El-Behaira Governorate, Egypt, of about 2.07 Kg/bed-day [20]. Birpinar *et al.* (2008) investigated 192 hospitals in Istanbul, Turkey, and reported an average generation rate of 0.63 Kg/bed-day [21]. Finally, Ruoyan *et al.* (2010) reported an average generation in Binzhou District, China, of about 1.22 Kg/bed-day [22]. The Souss-Massa-Drâa region has a much lower medical waste generation rate as compared to these regions. The difference may be due to living habitudes and standards, availability of treatment facilities and also ways to categorizing wastes. Marincovic *et al.* (2008) reported that the medical waste generation rate depends on the size and the type of the medical institution, but also that it differs from country to country based on the level of economic development [23]. Furthermore, the use of disposable instruments and packaging materials rather than the use of reusable items in the healthcare centres in developed countries has increased the amount waste generation.

One important component of a waste characterization program involves the determination of the composition of the wastes. A sound understanding of the contents of the waste stream is helpful in the development of realistic waste reduction and recycling programs. According to the survey, it was found that around 69.5% of medical wastes was general wastes similar in properties to municipal wastes. The remaining 30.5% was infectious and hazardous wastes. The percentage distribution of the composition of the medical wastes are presented at **Figure 1**: 69.5% is municipal, 10.6% is pharmaceutical and cytotoxic, 8.3% is biological, 7.4% is sharps, and 4.2% is pathological. Pruss *et al.*, (1999) found that 10% - 25% of medical wastes was termed as infectious, pharmaceutical, radioactive and chemical wastes [17]. In France, 15% - 20% of medical wastes is infectious-hazardous wastes [24] while in USA around 15% is considered as infectious and hazardous wastes [25]. According to a

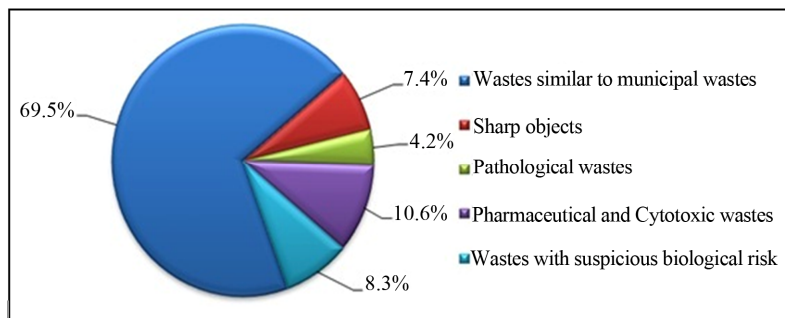


Figure 1. Percentage of the composition of medical wastes.

summary by Diaz *et al.* 2008, the total amount of medical waste generated in selected hospitals in developing countries varied from 0.016 to 3.23 Kg/bed-day and the percentage of infectious-hazardous waste in the total medical waste stream in developing countries was about 63% (From 0.01 to 0.65 Kg/bed-day) [26].

Waste generation source quantity and quality of waste generation are the key issues to decide an effective medical waste management practice. Therefore, it is important to minimize waste generation rate at each generation source. On this basis, appropriate medical waste separation at generation source can be an effective solution.

In the studied hospitals, medical waste separation is performed according to the types defined in Moroccan legislation (Table 1). Results from the questionnaires indicate that the knowledge of healthcare staff related to medical waste separation is generally low (Table 2). Housekeepers demonstrate a slightly higher knowledge about waste separation, with 49.4% of correct answers, with nurses at 45.7%, and doctors the lowest value at 38.6%. The highest percentage of satisfactory knowledge is related to municipal wastes, but more uncertainly occurs in pharmaceutical and cytotoxic wastes for all healthcare staff (Table 2).

These results are probably related to the level of daily waste contact; housekeepers and nurses are the healthcare staff groups with the highest levels of daily contact with medical wastes (76.7% of housekeepers and 67.1% of nurses). Doctors show the lower daily contact, with only 29.2% indicating such contact with medical wastes.

The different levels of knowledge about waste separation between healthcare staff groups may also reflect specific training concerning waste; housekeepers have the highest participation rates in training programs related to medical waste risks (80.8%), and doctors have the lowest participation (31.5%). About 70.8% of the nurses participated in these programs. Hence, the WHO advised that proper training and education must be offered to all workers from doctors to ward personnel, and most healthcare workers require the same basic set of skills, information and attitudes towards good waste

Table 1. Separation of medical wastes according to Moroccan legislation.

Waste type	Separation
Wastes with suspicious biological risk	Red bags
Sharp objects	Yellow boxes
Pharmaceutical and cytotoxic wastes	Brown bags
Pathological wastes	White boxes
Wastes similar to municipal wastes	Black bags

Table 2. Correct answers concerning waste separation procedures by healthcare staff.

Waste type	Doctors		Nurses		Housekeepers	
	N°	%	N°	%	N°	%
Wastes with biological risk	20	28.5	83	42.3	92	53.5
Sharp objects	24	34.3	87	44.4	79	45.9
Pharmaceutical and cytotoxic	13	18.5	61	31.1	43	25.0
Pathological wastes	27	38.5	91	46.4	84	48.8
Municipal wastes	51	72.8	126	64.3	127	73.8
Total	135	38.6	448	45.7	425	49.4

management [5]. If training is conducted on the job, it should help reinforce good practice and teamwork. Moreover, periodic repetition of courses will provide refresher training as well as orientation for new employees with new responsibilities; it will also update knowledge in line with policy changes [27,28].

Inadequate knowledge of waste separation as revealed in the survey is also shown with respect to knowledge of which coloured bag should be used for particular wastes (Table 3).

This inadequate waste separation will lead to inadequate treatment and final disposal of wastes, and could provide risks to healthcare workers, to the environment, and to human health. Results regarding the separation of pharmaceutical and cytotoxic wastes show that slightly

**Table 3. Inadequate waste separation and frequency of incorrect answers.**

Waste type	Inadequate answers to separation	Frequency %	
Pharmaceutical and cytotoxic wastes	Red bags	44.7	73.5
	Black bags	28.8	
Wastes with suspicious biological risk	Brown bags	25.5	42.4
	Black bags	16.9	
Wastes similar to municipal wastes	Red bags	7.7	19.6
	Brown bags	11.9	

less than three-fourths of healthcare staff (73.5%) responded incorrectly by identifying red or black bags. The adequate treatment specified in legislation for pharmaceutical and cytotoxic wastes is incineration and these materials should be collected in brown bags. However, pharmaceuticals and cytotoxics are stored by 44.7% of staff into red bags, which will lead to an autoclave of these wastes. This pre-treatment of such wastes is not suitable and could result in workers being exposed to volatile compounds between treatment cycles [29]. Some pharmaceutical and cytotoxic wastes are also erroneously collected in black bags (28.8%) and, as such, are considered to municipal wastes and sent to non-hazardous landfill. This could lead to the contamination of soil and water resources [17]. In addition, 25.5% of the suspicious biological risk wastes are incinerated because they are placed by healthcare staff in brown bag. This practice results in higher emission of pollutants [30] and greater treatment costs [1].

After the medical wastes are separated, workers should collect them and move them from the location of generation to temporary storage areas, based on the current regulations. From checklists and site visits, it had been observed that the management of medical wastes had not been conducted properly (**Table 4**); only two hospitals (28.6%) use appropriate equipment for their collection personnel.

As the Medical Waste Management Decree No. 2-09-139 outlined, workers are required to wear appropriate uniforms and protective equipment when collecting medical waste. It is important for workers to know and understand the potential risks associate with medical wastes, and the importance of consistent use of personnel protection [31]. In addition, only three hospitals (42.8%) had well sanitized their temporary storage areas. According to Pruss *et al.* (1999), the temporary storage location, storage containers and storage management have a direct impact on the resulting environmental and the health risks at the hospitals, which must be well sanitized, secured for access only to authorized personnel [17].

**Table 4. Assessment of medical waste management practices in the studied hospitals (N = 7).**

	N	%
Collection		
Workers wear protective equipment when collecting medical waste	2	28.6
There are defined procedures for collecting waste from specific units in the hospital	5	71.4
Storage		
There is a temporary storage within the hospital	5	71.4
The temporary storage areas are sanitized	3	42.8
There is special place for hazardous waste storage	5	71.4
Transportation		
Wastes are transported in suitable bags or containers	4	57.1
There are defined routes for transportation of waste within the hospital	5	71.4
Disposal		
There is a location of medical waste disposal site in the hospital	1	14.3
There is a company responsible for the final disposal	6	85.7

Furthermore, four hospitals (57.1%) have appropriate bags for the collection of medical wastes. Although the original waste bags should be resistant to be punctures during transportation, in order to reduce the cost, most of the plastic bags manufactured do not comply with this requirement. When punctured, these bags are torn and their contents which may be infectious and hazardous can be spread into the container and vehicle, and to the environment. Besides, most of the waste bags used are not marked indicating they contain medical wastes. Because of the absence of appropriate labelling, it is difficult for the public and workers to identify the source and the type of medical waste. Another problem faced is the high disposal costs of medical wastes in all surveyed hospitals. Because the quantity is low, there are no economies of scale and the disposal cost is high.

#### 4. Conclusions

The number of hospitals in the Souss-Massa-Drâa region, Morocco, is constantly increasing. This leads to an increase in the quantity of medical waste generated. Although the Ministry of Health together with the Ministry of Environment has developed regulations aimed to ensure appropriate handling and processing of medical waste, there is still need to put the regulations into practice.

The medical waste management situation in the region, while far from ideal, is better than in other parts of Morocco. To ensure improvement and continuity in the management practices, hospitals need to be integrated into

routine employee training, continuing education, and management evaluation processes for systems and personnel. They should provide secure methods of the medical waste collection and handling. The final goal is a system that is in harmony with sustainable development and protects the environment and human health.

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