Problems of management of medical solid waste at primary health care centres in the Palestinian Territory and their remedial measures

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مشكلات إدارة المخلفات الطبية الصلبة في مراكز الرعاية الأولية بفلسطين وتدابيرها التصحيحية

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الخلاصة: أُجريَت هذه الدراسة لاستقصاء جوانب إدارة المخلفات الطبية الصلبة في مراكز الرعاية الصحية الأولية في محافظتي نابلس وسلفيت بالضفة الغربية، فلسطين. وقام الباحث بإجراء مقابلات شخصية مع 190 من العاملين في مجال الرعاية الصحية في مراكز الرعاية الصحية الأولية في هذه المنطقة. وكانت المخلفات الحادة هي أكثر أنواع المخلفات تكراراً: وأفاد 5.3٪ فقط من المبحوثين أنه لم يتم على الإطلاق إنتاج المخلفات الحادة. وجاءت المخلفات المُعدية في المركز الثاني، حيث أفاد 40.4٪ فقط من المبحوثين بالمعالجة المستمرة للمخلفات الطبية الصلبة الخطرة. وقال أكثر من 80٪ من المبحوثين إن المخلفات الطبية الصلبة خلاف المخلفات الحادة يتم فصلها إلى مكونين اثنين مختلفين، لكن أفاد 20٪ تقريباً منهم أن المخلفات الحادة لا تُوضَع في أوعية خاصة. وتم تسجيل 34 غ في المتوسط من المخلفات الصلبة الخطرة و55 غ من المخلفات الصلبة غير الخطرة التي تنتج عن عمل كل عيادة من العيادات الخارجية كل يوم. ومن التدابير الهامة التي تقترحها هذه الدراسة من أجل تحسين ممارسات إدارة المخلفات: توعية العاملين وتدريبهم، وفصل المخلفات الطبية الصلبة، وإنشاء مرافق بسيطة لمعالجة المخلّفات.

ABSTRACT This study was conducted to investigate the management aspects of medical solid waste (MSW) at primary health care centres in Nablus and Salfit governorates in the West Bank, Palestine. We interviewed 190 health care staff from primary health care centres in this area. The most frequent type of waste produced was sharps waste: only 5.3% of respondents said this was never produced. Infectious waste was the second most frequent type produced. Only 40.4% of the respondents stated that hazardous MSW was always treated. Over 80% said that non-sharps MSW was separated into its different components, but almost 20% said that sharps were not placed in special containers. We recorded a mean of 34 g of hazardous solid waste and 55 g of non-hazardous solid waste generated per outpatient per day. Staff awareness and training, separation of MSW, establishment of simple treatment facilities are the major measures suggested for improvement of the waste management practices.

Problèmes de gestion des déchets médicaux solides au niveau des centres de soins de santé primaires dans le territoire palestinien et mesures correctives à cet égard

RÉSUMÉ La présente étude visait à examiner la gestion des déchets médicaux solides générés par les centres de soins de santé primaires des gouvernorats de Naplouse et de Salfit, en Cisjordanie (Palestine). Nous avons interrogé 190 personnels de santé travaillant dans les centres de soins de santé primaires de cette région. Les déchets pointus ou tranchants représentait le type de déchets le plus fréquent : seulement 5,3 % des personnes interrogées ont déclaré que ce type de déchets n'avait jamais été produit. Les déchets infectieux étaient le deuxième type de déchets le plus produit. Seulement 40,4 % des personnes intérrogées ont affirmé que les déchets médicaux solides dangereux étaient systématiquement traités. Plus de 80 % ont déclaré que les différents composants des déchets médicaux solides ni pointus ni tranchants étaient triés, mais, selon près de 20 % des répondants, les matériels pointus ou tranchants n'étaient pas placés dans des conteneurs spéciaux. Nous avons calculé qu'un patient en ambulatoire générait par jour en moyenne 34 g de déchets médicaux solides dangereux et 55 g de déchets médicaux solides sans risque. La sensibilisation et la formation du personnel, le tri des déchets médicaux solides et la mise en place d'installations de traitement simples sont les principales mesures suggérées pour améliorer les pratiques de gestion des déchets.

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Introduction

Sources of medical solid waste (MSW) include hospitals, diagnostic centres, primary health care centres (PHCs), research facilities, medical laboratories, private clinics, and dental clinics. The waste can be classed as hazardous or non-hazardous [1]. The characteristics that make MSW hazardous include infectivity, toxicity, radioactivity, chemical reactivity, and sharpness of objects.

Hazardous waste poses serious threats to environmental health and requires specific treatment prior to its final disposal [2]. Proper and safe management is necessary to avoid environmental and public health problems, particularly regarding the transmission of infectious diseases such as typhoid, acquired immunodeficiency syndrome (AIDS), cholera, and hepatitis B [3,4]. Therefore, facilities where MSW is generated should incorporate proper planning for waste management and risk reduction, taking into account the total cost for such actions [5–8].

In developed countries, MSW has long been taken into consideration through legislation and good practices guidelines that define MSW and state the various ways for its handling, treatment and final disposal. Various technologies are used for treatment and disposal, e.g. landfill, autoclaving, incineration, and recycling, with minimal risk to human health and to the environment [4,9,10].

In developing countries, however, MSW has not received adequate concern. In many countries, hazardous and medical wastes are not segregated and are managed together with domestic waste, thus creating a great health risk to workers in health care facilities as well as to municipal workers, the public and the environment [10–14]. In other countries, waste disposal options are limited, and incineration and open burning have been used as a solution.

In Palestine there is a lack of site-specific data on PHCs in regard to the composition and production rates of MSW based on actual measurements rather than assessments. Most of the studies were carried out in hospitals; few have been published about MSW in PHCs [15,16]. Most of the PHCs do not use an appropriate management system: their MSW passes through the municipal solid waste collection system and is disposed of randomly in dumping sites or sanitary landfills.

Nablus governorate is one of the largest in the West Bank of Palestine, while Salfit governorate is one of the smallest. Both are located in the Northern part of the West Bank. The population of Nablus governorate in 2007 was about 315 956 persons living in 64 localities: 174 403 in 8 urban localities, 111 197 in 53 rural localities, and 30 356 in 3 refugee camps [17]. The total population in Salfit governorate was 58 800 persons living in 20 localities: 21 334 in 3 urban localities and 37 466 in 17 rural localities. There were 28 PHCs in Salfit governorate and 63 PHCs in Nablus governorate in 2008 [18].

Real data are necessary for designing management strategies, assessing environmental impact, and calculating management costs [19–21]. The objectives of this study were:

- to assess the human factor in handling and treatment of clinical waste (i.e. to study the existing approach and its compliance with the WHO recommended procedures of the medical waste management rules);
- to quantitatively determine the amount of non-hazardous and hazardous waste in PHCs in 2 Palestinian governorates;
- to recommend a course of action for the proper waste management system for the large number of PHCs spread all over the Palestinian territory.

Methods

Questionnaire

The main tool used in data collection was a structured questionnaire in Arabic, designed specifically for this study by the author. The questionnaire aimed to collect information about medical staff and paramedical personnel, such as attitudes towards MSW, knowledge and behaviours in regard to MSW management such as segregation, regulations and guidelines, availability of necessary accessories, temporary storage, treatment, off-site transportation, final disposal, and occupational health and safety of all personnel working in the PHC.

The questionnaire was pre-tested on 15 respondents from the same area; only minor changes were made. Pretesting of the survey was conducted with an expert in environmental health from Birzeit University. The questionnaire was then administered to the participants. Responses were coded for statistical analysis.

Sampling and sampling frame

The target population of this survey was all medical staff and paramedical personnel working in all PHCs in Nablus and Salfit governorates in the northern West Bank.

The frame for all centres in the health care sector is updated annually by the Palestinian Central Bureau of Statistics (PCBS) through administrative records. The author took the sampling frame for the PHCs from the PCBS.

A random sample of 190 (61.3%) out of 310 medical staff and paramedical personnel from all 71 PHCs were interviewed; 13 of those originally approached refused to participate, and these were replaced to make up the ~60% target sample. The interviews were conducted during May and June 2010. The interviewer was an environmental health inspector. Interviews

were conducted during working hours and lasted on average 23 minutes.

Analysis of data was performed using *SPSS*, version 16.0. Descriptive statistics such as means and ranges were computed.

In addition, a special form was designed for field observation data collecting. The data were collected in all centres by the same environmental health inspector and were utilized in explaining some of the results. Information collected included colour of plastic bags used for the packaging of hazardous waste, availability of labels on hazardous waste containers, availability of a special storage place, etc. Staff were not aware that this information was being recorded.

Collection and separation of medical waste

For the purposes of the study, hazardous waste was defined as any waste material that came in contact with blood and other potentially infectious body fluids.

No specific methods have been proposed for the number of samples for solid waste characterization. According to the methodology recommended by Sharma and McBean [22], 30 samples are adequate. Based on this, we calculated 5 days × 20 PHCs = 100 samples, chosen to represent the 2 districts, were analysed. A collection programme was implemented for 20 randomly selected PHCs in Nablus and Salfit governorates to identify the main waste components (hazardous and non-hazardous) and assess the quantities produced. Waste collection and segregation took place over 5 consecutive days (most of PHCs in the study area as well as in other Palestinian governorates work only 5 days per week). The items in the following list were used for waste handling.

- Yellow waste containers, capacity 3 L: these were manufactured from rigid plastic and were labelled with the international symbol for infectious medical waste. They were used for sharp medical waste segregation and collection. They were washed and reused every day.
- Yellow polyethylene bags: these were purchased from a local supermarket and were used for hazardous, non-sharp, medical waste segregation and dumping after weighing. They were also suitable for preventing liquid leakage of leachate generated from the waste.
- Black plastic bags: these were purchased from a local supermarket and were used for non-hazardous waste segregation and dumping after weighing.
- Balance: an electronic balance with accuracy to 0.1 g.
- Electronic calculator.
- Daily waste recording forms.

Collection or bag containers were placed at convenient positions in each PHC. Facility personnel were supervised to ensure that the waste was collected in the correct container or bag. Containers and bags were collected and weighed by the end of the working day. During a collection day, the total amount of waste produced was collected, separated if necessary (only mixed waste was separated as sometimes part of the collected waste was not totally separated) and weighed. Weights were recorded using *Microsoft Excel*. Medical waste production rates from PHCs are expressed as kg/day (per centre) and g/patient per day. The separated solid waste components were classified as hazardous MSW and non-hazardous MSW.

Results

MSW management

At the PHCs in Nablus and Salfit governorates covered by this study, sharps wastes were produced more frequently than other types: 94.7% of the respondents reported that sharps wastes were always or sometimes generated (Table 1). A high proportion of the respondents (75.7%) also reported that infectious waste was generated always or sometimes. Other types of MSW were generated at lower rates.

Most of the respondents (89.5%) reported that sharps boxes were always available (Table 2). Nevertheless, only 73.6% stated that sharp objects were put into the boxes. Just over 60% of the

Table 1 Frequency of medical solid waste (MSW) generation according to type reported by health care staff (*n* = 190) at primary health care centres in Nablus and Salfit governorates, West Bank, 2010

Type of MSW	Frequency of generation (%)							
	Always		Sometimes		Never		Total[a]	
	No.	%	No.	%	No.	%	No.	%
Sharps	154	82.4	23	12.3	10	5.3	187	100.0
Infectious	70	36.8	74	38.9	46	24.2	190	100.0
Pharmaceutical	49	25.9	80	42.3	60	31.7	189	100.0
Radioactive	29	15.4	34	18.1	125	66.5	188	100.0
Heavy metal	28	14.8	53	28.0	108	57.1	189	100.0
Pathological	16	8.5	31	16.4	142	75.1	189	100.0

[a]*Some missing values.*

respondents said that they always separated non-sharps MSW into their different components, and 16.9% said that they never separated MSW. Only 38.4% of the respondents mentioned that yellow plastic bags were always available for MSW separation (Table 2). From the field observations, however, it was clear that PHCs normally used ordinary black plastic bags, and these were used for the packaging of hazardous waste and were not labelled. The international sign for infectious waste was on most of the sharps boxes, but was not marked on the hazardous MSW containers. In PHCs where separation of MSW was practised, all non-sharp hazardous wastes were collected in a single container.

The other types of MSW were collected in black plastic bags. None of the surveyed PHCs reported that specific segregation of recyclable waste materials was done.

Only 38.3% of the respondents reported that there was a special storage place at the PHC, and only 51.1% of these reported that the dedicated storage location was set up in a place which was not near the access routes of patients. From the field observations, it was noted that isolated compartments were not provided for the general and hazardous solid waste in the storage location owing to the lack of space in most of the PHCs.

Only 40.1% of the respondents reported that the transfer of MSW outside the healthcare centre was always done on a daily basis; others reported that it was disposed every 2 or 3 days.

Most of the respondents (94.4%) reported that hazardous non-sharps MSW were disposed of in public containers specified for domestic waste, while 5.6% mentioned that hazardous non-sharps MSW were burnt. Regarding sharps wastes, 66.3% of the respondents stated that they were disposed of in public containers, while 22.7% stated that they were sent to the governorate health directorate, and 11.0% said that they were burnt. The public containers were accessible to unauthorized personnel and scavengers.

Regarding the treatment of hazardous MSW, 40.4% of the respondents stated that it was always treated, 16.4% reported that it was sometimes treated, and 43.1% that it was never treated.

Only 25.0% of the interviewees reported that cleaning personnel always adhered to occupational safety measures, including using personal protection equipment such as gloves, overalls, boots and masks; 23.3% reported that they sometimes adhered to safety measures, and 51.7% that they never adhered to safety measures. The PHCs located in refugee camps had highest proportion of cleaning workers who adhered to professional safety measures, while those located in villages had the lowest proportion.

Because of the poor commitment of the cleaning personnel to safety measures, almost all the medical and paramedical staff (98.9%) emphasized the necessity for training and increasing the awareness of cleaners on how to deal with medical wastes safely.

Off-site transportation of medical waste was done once a week according to 33.3% of the interviewees, while 31.1% said it happened on a daily basis. In the rest of the PHCs, 18.4% of interviewees reported that it was 3 times per week in and 17.2% said that it was 2 times per week.

Training

Training programmes on MSW management for nurses, doctors, technicians, and cleaning personnel were limited. This was clear when most of the medical staff and paramedical personnel (92.5%) emphasized that training on medical waste management issues is very important for all of them. In addition, almost all medical staff and paramedical personnel (98.9%) emphasized the importance of training the cleaning personnel on MSW management issues.

Quantity of waste generation

In this study, the rate of MSW production was calculated per patient [1,23], and per primary health care centre. Table 3 presents the quantity of hazardous, non-hazardous and total MSW generation in the primary healthcare centres in Nablus and Salfit governorates. The mean quantity of hazardous MSW generation per PHC was 1.5 [standard deviation (SD) = 0.7] kg/day. Since the coefficient of variation was very high (46.7%), the median parameter of 1.0

Table 2 Attitudes and practices of health care staff (*n* = 190) regarding separation of medical solid waste (MSW) in primary health care centres in Nablus and Salfit governorates, West Bank, 2010

Question	Frequency (%)		
	Always	Sometimes	Never
Is there any control on MSW separation?	50.3	32.8	16.4
Do you separate non-sharp MSW into its different components?	60.8	22.2	16.9
Are yellow plastic bags available?	38.4	6.8	54.7
Are sharps boxes available?	89.5	8.9	1.6
Is sharps waste placed in special containers?	73.6	6.6	19.8
Are you ready to separate MSW if the necessary equipment is provided?	92.5	–	7.5

Table 3 Quantity of medical solid waste (MSW) generated daily in primary health care centres in Nablus and Salfit governorates, West Bank, 2010

Parameter	Hazardous MSW		Non-hazardous MSW		Total MSW	
	kg	g/patient	kg	g/patient	kg	g/patient
Mean (SD)	1.5 (0.7)	34 (33)	2.2 (0.8)	55 (22)	3.7 (2.1)	89 (42)
5th percentile	0.6	15	0.9	26	1.7	44
95th percentile	2.5	47	1.1	69	5.7	171
Coefficient of variation (%)	46.7	97.1	36.4	40.0	56.8	47.2
Median	1.0	26	2.1	54	3.1	81
Maximum	8.6	168	3.9	125	11.3	221
Minimum	0.5	13	0.6	21	1.2	35

SD = standard deviation.

kg/day could be a better indicator of hazardous MSW production. For non-hazardous MSW, the mean quantity was 2.2 (SD = 0.8) kg/day, and the coefficient of variation was 36.4%.

The mean total MSW production per patient was 89 (SD 42) g per patient per day (Table 3). As the coefficient of variation of 47.2% was relatively high, the median of 81 g per outpatient per day could be a better indicator for the per capita solid waste generation.

Discussion

In this study, almost 95% of the participants reported that sharps were sometimes/always produced in the PHC. This is most likely because PHCs vaccinate children against communicable diseases and as a result of the large number of vaccinations carried out daily, a large quantity of needles and syringes are used.

Less than two-thirds of the people interviewed said that non-sharps wastes were separated, and indication that separation practices were performed in an incomplete way in some of the PHCs, so that a portion of the hazardous MSW was mixed with general waste materials. Similar results were reported in a study in Serbian hospitals, where only sharps wastes were segregated from the other types of waste in strong plastic containers [24].

In many cases, staff reported that waste was collected in black plastic bags, contrary to the advice of WHO for separation [15]. In a study of health care waste management carried out in China, primary health care centres had a number of problems such as lack of equipment, poor waste separation, unsanitary storage locations, deficient protective measures, and unsafe on-site disposal [25]. The use of ordinary black plastic bags for separation and packaging of hazardous MSW is contrary to the advice of WHO [1,15], and the ones observed in this study were not even labelled.

A temporary storage place should be available within the PHC in order to avoid an accumulation of solid waste at the points of generation [1,15], however less that 40% of respondents reported this to be the case. It is important that if waste has to be stored before treatment, it should be placed in adequate, properly labelled packaging, accessible only to authorized personnel, and deposited in an area intended for that purpose only. Such a space should be out of the reach of staff and patients and properly marked. From our observations, space was limited/unavailable at many of the PHCs. Owing to this and also because of the lack of experience among staff and the lack of legislation regarding MSW management, isolated compartments were not provided so separation of waste was not always possible. The storage time for hazardous waste is also limited [26]. Similar findings to those in our study were obtained in a study conducted in El-Beheira Governorate hospitals in Egypt. It was concluded that the inadequacies in the hospital waste management practices were mainly related to unsafe storage of waste, ineffective segregation at the source, inappropriate collection methods, insufficient financial and human resources for proper management, and poor control of waste disposal [27].

In this study, over 40% of respondents said that hazardous MSW was never treated. The situation was different in a study in China where primary health care centres disposed of health-care waste by incineration on-site. Bad management and poor levels of operation were nevertheless evident [25], for example, the operating temperature of incinerators was sometimes below 800 °C, and in this situation, the incinerator can produce furans, dioxins, and other toxic pollutants. Incinerators were operated by poorly trained workers. Operations did not comply with standards related to environmental protection. Health care waste was often observed to be inappropriately discarded or mixed with domestic waste, creating a high potential risk to the environment public and health [25].

Only around one-third of the people interviewed said that waste was transported off-site daily. This means that, in

most of the centres during most of the year, MSW was stored in the municipal storage containers for a much longer time than recommended by the WHO for the climate conditions [1,15]. Most of the MSW was disposed of in public containers specified for domestic solid waste. Off-site transportation of general domestic waste is the responsibility of municipalities and village councils. Hazardous MSW should, of course, be transferred by the producers, clearly not the situation in most of primary health care centres in the study area as it is not segregated.

The vast majority of the staff interviewed in this study agreed that training was important, and particularly the training of cleaning personnel. This is in agreement with a 2008 study conducted in Serbia, in which training about waste management and the potential hazards and was not provided to doctors or other personnel [24]. No policy of SMW management can be effective unless it is applied carefully and continuously. Thus, the training of healthcare personnel on the implementation of this policy is critical to the success of a waste management programme. The overall objective of the training is to develop awareness in the field of health issues, safety and environment in regard to MSW, and the impact on staff during their daily work. Training must include all the PHC staff: doctors, nurses, assistant nurses, medical laboratory technicians and cleaners. They should be convinced of the need for a comprehensive policy for MSW management and the importance of training, and their value to the health and safety. This will ensure their cooperation in the implementation of such a policy [28].

A similar situation to that evident in this study was found in the healthcare facilities in Abadan, Nigeria. With the exception of tertiary healthcare facilities, management practices for dealing with medical waste were ineffective [29]. This was applicable across waste handling, storage, collection, transportation and disposal practices. Wastes were collected at the point of generation into drums, metal dustbins, baskets, etc., before transference into larger/final disposal containers. Waste handlers in some healthcare facilities opted to carry the containers with their bare hands or on their shoulders, which indicates a possible lack of training or awareness about the potential risks involved. In contrast, the tertiary healthcare facilities were offering wheeled plastic bins as well as pushcarts to facilitate easier and safer waste transfer.

The optimal solution for MSW management resulting from PHCs depends on the amount of wastes generated, and the opportunities available for the transfer of MSW to the treatment plant nearby. The first step is therefore to determine the quantities of waste generated from the PHCs [15]. There are many factors affecting this, mainly: number of patients per day, medical services supplied, and number of healthcare personnel. The rate of MSW generation in PHCs is also influenced by factors such as the economic, social, and cultural situation in the community, such as consumption patterns and lifestyle. Our findings in regard to the amount of hazardous MSW generated per PHC (mean 1.5 kg/day) are comparable with the findings of a study conducted in PHCs in the Islamic Republic of Iran, in which the mean total MSW waste generation per PHC was 3.8 kg/day [30]. Mean total MSW production per patient per day was 89 g, somewhat higher than the 63 g per patient per day recorded in the Iranian study [30].

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