Assessment of health-care waste generation and its management strategy in the Gaza Strip, Palestine

Reem Abukmeil¹ · Ali Barhoum² · Majdi Dher³ · Mitsuo Yoshida⁴

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Abstract

The situation of health-care waste in the Gaza Strip was threatening the environment and the public health due to the absence of appropriate health-care waste (HCW) handling, treatment, and disposal. In 2016, the total amount of HCW generated was estimated about 7199 kg day⁻¹. Around 20% of the wastes was infectious, and the on-site segregation was done only for sharps in most health care facilities, while other infectious wastes were comingled with noninfectious normal wastes. In 2017, a new strategy for the health-care waste management (HCWM) was adopted. The strategy stated the necessity to segregate the HCW into three categories at the generation source to sharps, infectious wastes, and noninfectious wastes. The strategy was implemented over 40 clinics. The proper on-site segregation of the infectious and sharps showed that 2.4 kg day⁻¹ and 0.7 kg day⁻¹ of wastes is generated from UNRWA and Ministry of Health (MOH) clinics, respectively. This generation quantity accounts for a rate of 11 g per outpatient at UNRWA clinics and a ratio of 9.5 g per outpatient at MOH clinics. These quantities account for 33% and 54% of the total waste from UNRWA and governmental clinics in South and Middle Gaza.

Keywords Health-care waste management · Infectious waste · Sharp waste · On-site segregation

Introduction

According to the World Health Organization (WHO), about 85% of the total amount of solid wastes generated by health-care activities is general and noninfectious waste, the remaining 15% is considered hazardous material that may be infectious, toxic, or radioactive [1]. Such infectious wastes should always follow an appropriate and well-identified stream of management from their point of generation

until their final disposal. Especially in the recent decades, the increase in the size of health care facilities has posed a growing stress for the proper management of health-care wastes [2–4]. The specific concerns of health-care wastes come from the potential risks to human health and the environment [5, 6].

In most developing countries, the situation is critical with no adequate health-care waste management (HCWM) system at present [7]. In Palestine, the proper handling of health-care wastes has received little attention [8]. In particular, the situation was very critical in the Gaza Strip, in which one of the major threats came from the mixture of infectious wastes with mainstream noninfectious normal waste [9]. Much of the waste had, therefore, ended up in general dumpsites without any treatment [10].

In 2010, the Palestinian National Authority compiled a report on the Development of a National Master Plan for Hazardous Waste Management in West Bank and Gaza [11]. The report found that only one-third of the health care facilities used special bags for health-care waste collection in the Gaza Strip, whereas all other facilities consequently collected all types of health-care wastes together with noninfectious normal waste, except for sharps that were basically

✉ Reem Abukmeil
reem.abukmeil@dal.ca

¹ Gaza Medical Waste Management Program, Japan International Cooperation Agency (JICA) - Palestine Office, Presently at Dalhousie University, Truro, Canada

² Joint Service Council for Solid Waste Management in Khan Younis, Rafah and Middle Area (JSC-KRM), Gaza, Palestine

³ Preventive Medicine Department at Ministry of Health, Gaza, Palestine

⁴ JICA Technical Cooperation Project for Technical Assistance in Solid Waste Management in Palestine, Presently at Global Environment Department, Japan International Cooperation Agency (JICA), Tokyo, Japan

being collected in special boxes. The report also stated that 80% of health facilities in Gaza had no way to securely store health-care waste. It mentioned that the waste was generally collected by the municipality without any distinction between health-care waste and noninfectious normal waste, and eventually all types of waste were transported in the same vehicle. The report stated that 70% of the collected health-care wastes in Gaza were incinerated, while 20% were burnt in the open air, frequently in waste bins. And the remaining collected health-care wastes invariably ended up in municipal waste dumpsites. There was no documentation or registry of any records on generation rate, quantities of health-care wastes, or even the incinerated items. The report estimated the volume of health-care waste at $1.3 \text{ kg bed}^{-1} \text{ day}^{-1}$ with an annual waste quantity at 2379 tons, including 20% hazardous waste. This estimated figure is the same as the previous estimation of $1.3 \text{ kg bed}^{-1} \text{ day}^{-1}$ for the West Bank and close to the estimation of $1.36 \text{ kg bed}^{-1} \text{ day}^{-1}$ in Jordan with similar treatment practices and culture [12, 13]. Another research was conducted as a dissertation of a graduate degree in the Islamic University of Gaza in 2014, which estimated $1.8 \text{ kg bed}^{-1} \text{ day}^{-1}$ as the average generation ratio of health-care waste in hospitals [14].

In 2012, a feasibility study of solid waste management in the Gaza Strip estimated that approximately 3800 kg day^{-1} of health-care waste is generated [9]. The Brescia University of Italia conducted a research in cooperation with an Italian NGO COOPI (Cooperazione Internazionale Italy), which estimated the total health-care waste generation in Gaza at 3357 kg day^{-1} [15].

The Palestinian bylaw to introduce HCWM No. (10) of 2012 was formulated in 2012. However, most of the health-care wastes are still disposed of by commingling with noninfectious normal waste without pre-treatment [16]. Since then, the strategies proposed to handle these issues were hardly implemented, and the legislation in this area was still very weak [9]. In 2014, new intervention initiated to improve the overall waste management systems in Gaza [17], however, little attention was given to health-care waste management.

Under the circumstances described above, a new strategy has been implemented in 2016 under the technical assistance of Japan International Cooperation Agency [19], based on the minimum requirement of WHO in terms of separating the health-care wastes into three categories: sharps, infectious, and noninfectious. The key to success of implementing the new strategy is to: (i) prevent dumping the infectious waste with noninfectious normal waste, and (ii) control the illegal dumping of infectious waste in municipal bins. The present research aims then to examine the generation quantities of sharps and infectious wastes after the implementation of the new strategy and to develop a manifest system that shall track the infectious waste from source until disposal.

Materials and methods

Direct measurements are applied for collecting the weight of waste generated and for examining the accuracy of separation of infectious waste generated at the source. The measurement included weighing the wastes in the source and in the treatment facility using manifest records. Visual inspection was done in the source to ensure the proper separation of sharps and infectious wastes.

Results and discussions

Health-care waste status in the Gaza Strip

The narrow area of the Gaza Strip with an estimated population of 1,989,970 residents [18] consists of five governorates: North Gaza, Gaza, Middle Area, Khan Younis, and Rafah. The municipal solid waste management service is currently performed by 25 municipalities that mainly manage the primary collection to transport the noninfectious normal waste from households to waste bins and/or transfer stations, except for the refugee camps that are managed by the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). The secondary collection is the responsibility of Joint.

Service Councils (JSCs) or municipalities, which is to transport noninfectious normal waste from waste bins and/or transfer stations to landfills [9].

In the municipal solid waste management cycle, the management of health-care wastes is under the responsibility of Ministry of Health (MOH). In 2016, the health care facilities consisted of 13 MOH hospitals, three Military Health Services, and 14 Non-Governmental Organization (NGO) hospitals that provided treatments for inpatients and outpatients. There were also 54 MOH clinics, 21 UNRWA clinics (in 2020, the total number of UNRWA clinics is 22), and 77 small NGO clinics. Those clinics provided health services for outpatients only (Fig. 1).

Most of the governmental and NGO hospitals and clinics were applying waste separation only for sharps, and all the other infectious wastes were collected together with noninfectious normal wastes, which were transported and disposed of in municipal solid waste dumpsites. The segregated sharps were treated using two existing incinerators with a capacity of less than 250 kg day^{-1} . In addition, an autoclave was possessed by MOH with a capacity of 50 kg per 30 min, which had not been operated properly due to technical and logistical constraints.

Health-care wastes were separated into three categories only in UNRWA clinics and two other private hospitals.

Fig. 1 Distribution of Health Institutions in the Gaza Strip. Adapted from the JICA Final report on the survey of medical solid waste in Gaza, Palestine

Sharps were stored in safety boxes, infectious waste in yellow-coloured plastic bags, and noninfectious normal waste in black-coloured plastic bags. However, infectious wastes segregated into yellow-coloured plastic bags were not separately transported to the treatment facility but were transported with other municipal wastes to disposal sites. Most of the hospitals/clinics did not have adequate storage for health-care waste and stored the safety boxes and yellow bags inside the facility or in open areas in the backyards. As a whole, most of the generated health-care wastes containing infectious wastes were discharged into municipal waste bins and collected and disposed to dumpsites mixed with municipal solid wastes, which posed significant health risks to both waste management workers and the public.

In 2016, an unpublished report by Japan International Cooperation Agency (Palestine Office) on the survey of health-care waste in Gaza gave an estimation for the health-care waste generation per outpatient. The report revealed a generation of 34 g per outpatient at UNRWA clinics, and 73 g per outpatient at MOH clinics. While the generation

from hospitals was ranged from 80 to 100 g per emergency outpatient and 1.88 kg per inpatient per day. Accordingly, the amount of total waste generation from health care facilities in Gaza was estimated to be around 7199 kg per day, while the estimated total amount of infectious waste, including sharps, was calculated using the number of beds to be 1071 kg per day.

Strategy for improving health-care waste management

On-site HCWM is the management process conducted inside health care facilities that includes source separation of waste generated and storage of the waste before the collection. While, the off-site health-care management covers the management process conducted outside the health care facilities, such as separated collection, treatment, and final disposal, after discharging the infectious waste from the health care facilities. The collection of sharps and infectious wastes and the operation of incinerators were under the operation of MOH without inducing a tariff of polluter producer.

However, an independent entity was discussed to be most suited for taking responsibility for the collection of sharps and infectious wastes. Tariff collection for treatment services was also discussed to be under the responsibility of an independent entity instead of MOH to ensure the credibility of waste treatment and safe disposal. While MOH should keep the responsibility with reference to the HCWM legislation to obligate all health institutions to segregate wastes into three categories at the generation source: sharps, infectious wastes, and noninfectious wastes. Since landfills were owned and operated by JSCs in the Gaza Strip, it was expected that JSCs should be the entity responsible for exclusive transport and final disposal; and they were expected to be responsible for managing treatment activities. This new strategy was decided by Palestinian Authorities and all stakeholders in late 2017, and it was practically verified by on-site and off-site activities in South and Middle Gaza. Figure 2 summarizes the newly introduced strategy for the HCWM system in the Gaza Strip.

Generation of sharps and infectious waste after implementing the new strategy

The new strategy was implemented on 13 UNRWA clinics and 27 MOH clinics in the South and Middle Gaza. This number of target health care facilities represents 62% of UNRWA clinics and 50% of MOH clinics in the Gaza Strip. Results showed that the average generation from UNRWA clinics was $72.3 \text{ kg month}^{-1}$, approximately 2.4 kg day^{-1} . Based on the data collected from the number of outpatients in each clinic from February 2019 to December 2019 from both MOH and UNRWA clinics (Fig. 3), we were able to calculate the generation of sharps and infectious waste per outpatient. Analysis using MS-Excel showed that the average generation of

sharps and infectious waste from target UNRWA clinics was 11.0 g per outpatient, as shown in Fig. 3 in comparison to 34 g per outpatient before the implementation of the new strategy.

It is noticed that June had the lowest waste production even though the number of outpatients was higher than the previous four months. We compared the number of outpatients of different clinical departments in June with other months that had similar number of outpatients. We noticed that the number of outpatients who had been treated at the vaccination, intra-uterine device services, laboratory, dressing, and injection departments were more or less similar in number for June, March, April, and August 2019. However, the number of outpatients who had been treated at the curative and preventive dental department were less by 9.4%. Thus, the changes in consumables used at the dental departments significantly affected the amount of infectious wastes generated.

While for MOH clinics, the actual measured data indicated that the average generation amount of sharps and infectious waste was approximately $19.6 \text{ kg month}^{-1}$, which was about 0.7 kg day^{-1} . Based on the data collected on the outpatient numbers from February 2019 to January 2020, the average generation of sharps and infectious waste of target MOH clinics was 9.5 g per outpatient, as illustrated in Fig. 3, in comparison to 73 g per outpatient before the implementation of the new strategy. The generation quantity of infectious wastes in May 2019 was the lowest compared to other months that had similar number of outpatients. We compared the number of emergency treatment cases, the records showed similar number of urgent cases were received in May, October, and November 2019 (1094; 951; and 1167, respectively). Thus, the reduction of generated quantity might have been due to the number of consumables used at that month.

Fig. 2 Proposed new health-care waste management system in the Gaza Strip

Fig. 3 Generation of infectious and sharps per outpatient of MOH and UNRWA clinics in South and Middle Gaza

By applying this new strategy to other health care facilities in South and Middle Gaza, 40% of the total generated HCW can be treated properly as of 2019.

Role, responsibility, and manifest system

In addition to responsibility sharing between JSC and MOH, a manifest system was applied under this study to confirm the exact flow of infectious waste within the HCWM by taking the record of the discharging infectious waste (=the output of on-site management) (Fig. 4). Initially, the new strategy was prepared as a formatted voucher-based manifest

system, but later was converted to a computer-based electronic manifest system. Whenever infectious waste passes through each stage of HCWM process (discharging, collection, transportation, treatment, and final disposal), the manifest confirms the execution status of each process, and the treatment is processed for all infectious wastes without omission. This type of monitoring process confirmed the accuracy of treating the amount of infectious wastes from source before dumping them into the disposed site. We inspected the records of manifests to confirm whether generated sharps and infectious wastes were fully treated to calculate the accurate amounts. The institutionalization

Fig. 4 Role and responsibility of each stakeholder and manifest system

Fig. 5 Pictures of segregated container for infectious waste (red category) in hospitals (Left), Segregated box for used syringes and sharps in hospitals (Middle), and Infectious waste collection by Joint Service Council (Right)

of periodic inspections using the manifest system by the MOH and Environment Quality Authority (EQA) is a future challenge.

Accuracy of health-care waste separation quality

To evaluate the quality of health-care waste separation, researchers performed site visits at disposal sites and onsite the target health care facilities. The site visits included evaluation the accuracy of waste separation by opening the designated bags of health-care wastes. The researchers noticed poor segregation of infectious wastes at the beginning of implementing the new strategy. Noninfectious normal wastes such as food boxes, tissues, papers were noticed to be mixed in the designated bags for infectious wastes. Evaluation sheets were then prepared to evaluate the awareness at the level of generation source and segregation of health-care waste, the awareness about placement of coloured plastic bags in plastic bin and availability of sharps boxes for sharps, and finally the awareness among health-care waste handlers. The evaluation was carried out in a 13 UNRWA clinics and 25 MOH clinics in South and Middle Gaza.

It was observed that out of total 38 places of waste generation, 31 (84%) were having all three colour coded bags and all places have the right place of sharp boxes (Fig. 5). 158 (27%) participants out of 596 responses, who were health-care service providers and infection control officers, had taken some trainings on HCWM in the past, while 69 (60%) participants out of 115 responses, who were cleaners, got previous training on HCWM. 99 (90%) participants out of 110 total responses stated that their job description clearly identified the role of health-care waste collection within the health care facilities as a cleaner. On the other hand, only 99 (16%) participants out of 606 responses, who were of health-care service providers and infection control officers, were aware of their own responsibility to segregate the health-care wastes, which shows that the authority did not provide them with a clear job description.

Evaluation results indicated that a lack of training among the health staff and waste management workers for separating the wastes is challenging the quality of implementing the new strategy. The responsible authorities shall consider a capacity-building program as an indispensable for

the functioning of the new strategy for HCWM, and it is required to be held continuously as new staff members will join in and replace previous members.

Conclusions

Before the implementation of the new strategy of HCWM, the situation of health-care waste in the Gaza Strip was threatening further deterioration of the environment and the public health due to the absence of appropriate health-care waste handling, treatment, and disposal. Most of the infectious health-care wastes were disposed of with noninfectious normal waste in municipal waste streams, except for sharps. Municipalities and JSCs were basically responsible for collecting and transporting municipal solid waste; however, municipal waste contaminated with infectious health-care waste had been collected and transported to final disposal sites by municipality/JSC workers without any safety precautions. The new strategy has created a new plan for HCWM system based on current situation. The study confirmed the necessity for training human resources as a vital component for the success of the new system. The implementation of new HCWM has started in South and Middle Gaza, and the next challenge is to implement the system in North Gaza. MOH is expected to be more involved in the monitoring, supervision, and regulation of activities related to health-care waste treatment. The program has brought about significant effects of institutionalization for the sector of HCWM in Gaza, and enhancement of the capacity of concerned authorities such as MOH and JSCs for conducting on-site and off-site management service. However, there are still twofold challenges: reducing the operation and maintenance (O/M) cost and continuing the training of MOH and JSC staff.

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Declarations

Conflict of interest The technical cooperation program was financially supported by JICA, UNRWA, UNDP, Representative Office of Japan, and Qatar Charity. The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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