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ASSESSMENT OF WASTE MANAGEMENT SYSTEM IN HOSPITALS AFFILIATED WITH URMIA UNIVERSITY OF MEDICAL SCIENCE IN 2013

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Abstract

Background and Objective: Aggregating, sorting, and disposing of hospital wastes is of critical importance, given the risk they impose on the public health. Therefore, the present study is aimed at examining medical waste management system in educational medical centers associated with Urmia University of Medical Science in 2013.

Materials and Methods: The study was carried out as a cross sectional work in all medical and educational centers associate with Urmia University of Medical Science through description, questionnaire, observation, and interview. The collected data was analyzed in Excel.

Results: The results showed that 40% of the hospitals under study had received waste management operation plan and only 20% of them had prepared a list of hazardous materials produced in the hospital. Standards of handling chemical waste was not followed in any of the hospitals.

The centers under study produced 4465 kg medical waste every day; out of which, 1897 kg (42%) was infectious waste and 2565 kg (58%) was non-infectious waste. Volume of sharp and pointy wastes was 20.5 kg/day, and volume of chemical and pharmaceutical waste was 0.012 kg/day.

Conclusion: The results showed that performance of the waste management system was not satisfactory and majority of the hospitals had taken no measure to handle chemical and pharmaceutical wastes in particular. It is notable that

extending accurate supervision system could be an effective step toward reducing the waste production volume and improving quality of management, supply, preservation, and improvement of the patient, the personnel, and the public health.

It is worthy to note that holding training courses for all personnel including interns, residents, nurses, and nurse assistants are necessary to reach the objective of medical waste management law.

Keywords: Waste management, urmia medical and educational centers, infectious wastes

Introduction

One of the main contaminators of the environment is solid wastes, which could cause serious damages to the main elements of the environment (i.e. air, soil, and water in particular) if not managed properly. World health organization (WHO) announced that failure to implement waste management standards can cause 22 major environmental problems, which are not easy to deal with (1-2).

Among the places that infectious wastes are produced are medical and health centers, medical laboratories, and other institute of similar nature. According to the definition, medical wastes are all infectious and harmful wastes that need special care due to high level of health threatening attributes such as highly poisonous, pathological, explosive, flammable, and corrosive (3).

According to WHO estimates, with an effective medical waste disaggregation system, pathological-infectious, normal, sharp and pointy objects, chemical and pharmaceutical wastes, and special waste constitute 80%, 15%, 1%, 3%, and less than 1% of the waste respectively (4). One of the basic ways to prevent and control infectious diseases in medical centers is to ensure commitment of different levels of personnel to the health codes designed to optimize solid waste management system. Since medical wastes, with many pathological factors, are considered as a serious threat to public health and environment, they have drawn special attention of the public and the authorities (5).

Failure to follows the codes and standards for handling and disposing of medical waste is a serious risk. One of the threats, which is less taken into account, is nosocomial infection that happens due to failure to carry out standard disinfection, disaggregation, and handling process in hospitals. Medical waste management standards are growing in terms of strictness and comprehensiveness so that managers of health services providing institute are required to take measure to reduce waste production volume, recycle, disaggregate, and separate the waste as the most effective strategy toward reducing costs of waste management system (1, 5, 6). In the same spirit, medical wastes management is treated by the most of health centers in the world as a serious challenge. Ineffective waste management in terms of

collecting and disposing the waste, given the nature of the waste, creates notable health threats and environmental pollutions (1). Lack of an effective management system to reduce the risks of medical wastes intensifies the health threats to the public health (6).

Medical centers that effectively implement waste management systems produce far less volume of hazardous wastes comparing with the centers that fail to implement such systems. In absence of an institutionalized waste management system in the source and failure of the managers to comprehend necessity of this system, medical waste production volume in Iran is much more than that of other countries so that the problem has emerged as a managerial crisis in large cities (7-8). Wide range of studies have been carried out on per-capita production volume and qualitative and quantitative specifications of medical waste. Studies in 2001 on 122 Tehran-based hospitals reported rate of medical wastes production equal with 2.7 kg/bed.day. Jalilzade et al. (2009) reported that in the West Azerbaijan, 1.9 and 1.7 kg/bed.day medical wastes are produced in university associate and non-university associated hospitals respectively (9).

Therefore, infectious waste produced in medical centers needs special management given their high risk. Otherwise, tragic environmental and social outcomes are inevitable. Given the above introduction, the present study is aimed at surveying medical wastes management condition in health providing centers affiliated with uremia Medical Science University in 2013.

Materials and Methods

A cross sectional study was carried out through field observation and filling out questionnaire in hospital wards. Following WHO's recommendations about validation, standard questionnaire was collected from uremia Health Organization. The questionnaires were filled through interviewing with the personnel dealing with solid waste management and environment health experts in hospitals.

The questionnaire is comprised of open-ended questions about general information of the hospitals such as number of operational beds, nominal number of beds, bed occupation rate, number of personnel working in waste management ward, volume of infectious, non-infectious, sharp, pointy, chemical, and pharmaceutical wastes, waste management operation, waste recycling, recycle bin cleansing and disinfection section, wastes sterilization section, and few other questions. In addition, field observations were performed to collect more information and examine solid waste management operation in practice. According to medical waste management guidelines in Iran, the four groups of solid wastes (quasi-household, infectious, sharp/pointy, and chemical-pharmaceutical) were weighed in two weeks

per month for six months after making arrangement with authorities of the hospitals and the experts in charge of waste management in all the hospitals under study. Waste weighing operations were performed twice a week at the end of work shifts after knotting the infectious and noninfectious waste sacks and placing them in trolleys designated in each ward (yellow trolley for infectious wastes and blue trolley for non-infectious waste). The trolleys would be removed to ground floor using an elevator and the wastes would be stock in a temporary waste post at the hospital yard. The waste would be weighed at the post by an operator under supervision of environment health control and weighing experts. Eventually, waste production volume per bed/day would be obtained by dividing total weight of the waste by number of beds (kg/bed, kg/day). Comparison model in our survey was the waste collecting, handling, and disposing guideline issued by the Ministry of Health, Medical Education, and Treatment and the environment and information health by-laws. Study population was comprised of five educational hospitals including Imam Khomeini, Ayatollah Taleghani, Shahid Motahari, Seyed Alshohada, and Razi (psychology) hospitals.

Results

The results showed that 40% of the educational hospitals had received operational plan of waste management and only 20% of the hospitals listed type of hazardous wastes. Radio drug wastes were only produced in Imam Khomeini Hospital of which the type, half life-cycle, and usage are listed in Table 1. Table 2 and 3 list the mean per capita of different types of solid wastes and general information of the hospitals under study. Volume of waste (kg/day) and are listed in Table 4 and Table 5 lists type of disinfection systems (non-incineration). None of the hospitals had a special procedure to collect and manage chemical wastes and the trolleys would be cleaned after disposing the waste only in 60% of the hospitals. Only one hospital (20%) had locker room, bathroom, and recreational facilities especially designed for the personnel of waste management operation. Moreover, 60% of the hospitals had personal safety facilities for waste management personnel (Table 6).

The results showed that on average, 4465 kg/day waste is produced in medical educational centers in uremia, which was comprised of 1897kg. (42%) of infectious waste, 2565kg (58%) of non-infectious waste, 20.5kg of sharp and pointy waste, 0.012kg. of chemical and pharmaceutical waste (Table 4).

Table 1. **Half life cycle and usage of radio drug wastes produced in urmia Imam Khomeini Hospital.**

Half-life (after 10th half-life)	**Usage**	**Half-life**	**Radio drug**
80.4 day	Thyroid work, thyroid imagery	8.04 day	^{131}**I**

	Brain imagery, kidney failure, lung respiration		
2.5 day	imagery, the brain, thyroid, saliva glands, blood pool imagery, liver, spleen, bone marrow imagery	6.01hr	^{99m}**Tc**
32.6 days	Tumor imagery	3.26 day	^{67}**Ga**
33.29 days	Heart muscles, blood circulation	79.9hrs	^{201}**Tl**

Table 2. **Mean per-capita of different types of solid wastes produced in uremia educational medical centers (kg/bed.day) in 2013.**

Hospital	Non-infectious waste (quasi-household)	Infectious	Sharp and pointy	Chemical	Radioactive (kg/Patient.day)
Imam Khomeini	3.08	2.34	0.029	0.0049	0.0192*
Shahid Motahari	2.32	1.8	0.014	0.0024	
Ayatollah Taleghani	2.01	1.53	0.014	0.0019	-
Seyed Alshohada	1.99	1.91	0.015	0.0026	-
Razi (psychology)	2.31	0.165	0.068	0.00013	-

* Nuclear medicine center is only available in Imam Khomeini Hospital

Table 3. General Information of urmia medical educational centers.

Hospital	Services	Bed occupancy rate	Number of waste management personnel	Nominal number of beds	Functional beds
Imam Khomeini	The West Trauma Center	90%	135	297	450
Shahid Motahari	Children-women	78%	72	300	267
Ayatollah Taleghani	Infectious	92%	43	450	220
Seyed Alshohada	Heart	90%	32	155	145
Razi (psychology)	Psychology ward	78%	19	82	93

Table 4. Waste production rates in urmia Educational Hospitals.

Produced waste (kg/day)			Functioning beds	Hospital
Total	Non-infectious	Infectious		
2200	1250	950	450	**Imam Khomeini**
835	470	365	267	**Shahid Motahari**
740	420	320	220	**Ayatollah Taleghani**
510	260	250	145	**Seyed Alshohada**
180	168	12	93	**Razi (psychology)**
4465	(%57)5867	(43%)1897	1175	**Total**

***** The hospital disinfect the infectious wastes using autoclave machine in the plant of a private contractor

Table 5. Waste disinfection systems (non-incineration) in urmia Educational Hospitals.

Type of disinfection system	Non-incineration disinfection machine	Hospital
Autoclave Hydroclave	2	**Imam Khomeini**
Autoclave	1	**Shahid Motahari**
Autoclave	1	**Ayatollah Taleghani**
Autoclave	1	**Seyed Alshohada**
None	0	**Razi (psychology)**

Table 6. Solid wastes management and the equipment needed in urmia educational hospitals.

Percent (%)	Frequency	Equipment and sets	Number
40%	2	Having waste management operation plan	**1**
20%	1	A list of types and places of stocking hazardous wastes	**2**
100	5	Availability of waste handling facilities at site	**3**
0%	0	Disaggregation of chemical waste in special sacks and in white or brown containers	**4**
100%	5	Storing sharp and pointy wastes in standard containers (safety box)	**5**
2%	1*	Collecting radiating wastes separately under supervision of physical hygiene expert	**6**
100%	5	Collecting noninfectious waste in strong black sacks and stocking in washable blue containers	**7**

80%	4	Availability of proper washable bins with pedal lid with strong sacks	**8**
100%	5	Stocking dead body limbs and embryo in proper place (e.g. fridge)	**9**
100%	5	The sacks and safety boxes are knotted when three-fourth of their volume is filled	**10**
80%	4	Sacks and safety boxes are labeled	**11**
60%	3	Waste container are washed in disinfected before refilling	**12**
100%	5	A proper place is available to wash and disinfect waste containers	**13**
100%	5	The wastes are transported to temporary stock place using wheeled trolleys or bins with specifications as per the guideline	**14**
60%	3	Waste transportation containers are washed and disinfected with proper materials	**15**
100%	5	Availability of a temporary waste stock place in the hospital	**16**
40%	2	The temporary waste stocks place is equipped with standard proper ventilation, access way, sewage system, hot and cold water taps, washable floor, roof.	**17**
60%	3	Wastes stock place is marked by visible sign and secured by proper lock	**18**
100%	5	Different types of waste are stocked separately	**19**
100%	5	Using non-incineration method to disinfect the waste	**20**
0%	0	Following standard methods to dispose of chemical wastes	**21**
100%	5	Documents of microbial survey system and confirmation of the operations are available	**22**
0%	0	Operation certificate documents are available	**24**
0%	0	Systems calibration documents are available	**25**
100%	5	Well-trained staff operates the disinfection system	**26**
60%	3	The staff handing the waste and the machines are equipped with safety equipment	**27**
100%	5	The staff handling the waste are trained properly	**28**
20%	1	There are adequate locker room, bathroom, and recreational facilities for the staff handing the waste and cleaning the bathrooms.	**29**

100%	5	Health files (vaccination card, periodical examination card, etc.) are available for all staff handling the wastes	**30**

* Radioactive waste produced in nuclear medicine ward of Imam Khomeini Hospital.

Discussion and Conclusion

The results showed that among the hospitals under study, only Imam Khomeini hospital had a nuclear medicine ward and consequently radioactive wastes such as iodine 131, Technetium-99m, gallium 67, and Thallium 201were produced in the hospital. Among the radio drugs, Technetium-99m is the most widely used medicine for diagnostic purposes such as brain imagery, kidney failure, lungs respiration imagery, thyroid, saliva grand imagery, blood flood imagery, spleen, and bone marrow. Chemical wastes or cytotoxic wastes are also produced in cancer ward of Imam Khomeini Hospital (10). Outpatients and hospitalized patients in this hospital received services every day except for Fridays.

The main portion of radioactive wastes was in the form radio Drug vials, angiocatheter, and syringe. Every day, on average, 340gr. of radioactive syringe was produced as a result of providing health service to 17.71 patients. Each patient causes production of 0.0192 kg of radioactive wastes per day. Minimum and maximum weight of radioactive wastes were produced on Saturday/Thursday and Monday and Wednesday respectively. According to the latest instruction about radioactive wastes management, the wastes could be disposed of with usual wastes after 10^{th} half life cycle. For example, iodine 131 waste (half-life 80.4) needs to be stocked in waste room in lead covered container for ten days before being disposed of with usual wastes (Table 1). For safety sake, radioactive waste shall not exit waste chamber before 10^{th} half life cycle of the waste.

Contribution of educational hospitals in production of infectious and non-infectious wastes in urmia city is listed in Table 2. Because, Imam Khomeini hospital is the west trauma center of the country with variety of wards such as lung, digestion, orthopedic, surgery, neurology, NTE, blood, rheumatology, nephrology, urology, and kidney implantation, great volume of waste is produced in the hospital so that 5.42kg/bed/day waste is produced in the hospital, which is far more than the other hospitals. Another reason for this high volume of waste produced in this hospital is that nursing, anesthesia, and surgery room technician trainees, interns, externs, and residents of the said specialties are also work in the hospitals and many of them are not familiar with wastes disaggregation codes. Therefore, the high volume of medical waste produced in this hospital are not properly disaggregated. Moreover, two hours public visit per days and social cultural structure of the local population are of other factors, that along with lack of a waste management operation plan, increase volume of waste produced in this hospital. On the other hand,

volume of medical wastes produced in Razi Psychology Hospital is far less than that of produced in other hospitals given the fewer number of visitors and that no surgery operation carried out in the hospital.

Several studies have been carried out with respect to the rate of variety of solid waste materials produced by hospitals. A study in Turkey (1995) showed that rate of infectious waste produced by public and private hospitals was 4.34 and 2.39 kg/bed.day respectively (11). A study in Brazil showed that average rate of infectious and noninfectious waste produced by hospitals in this country were 3.24 and 0.57 kg/bed.day respectively (12). Bedoor et al. (2007) reported that public hospitals in the north of Jordan produced about 3.49 kg/bed/day wastes (13). Inconsistent with our results, Moghada Maghdi Abdolslam et al. (2007) studied eight hospitals in Damanhour city, Egypt and showed that about two-third of hospital waste was quasi-household waste and the rest (38.9%) was hazardous waste (3). Their study showed that the rate of medical wastes production varies widely, comparing with other countries, in absence of an integrated waste management system, due to different level of knowledge of the producers (patients, visitors, and personnel), and different cultural social knowledge. Studies conducted in Iran have reported different results, Asgarian and Vakili (2001), consistent with the present study, reported about medical wastes produced in Fars-based educational hospitals affiliated with Shiraz University of Medical Science that 3.93 kg/bed.day waste was produced in the hospitals (51.5% noninfectious wastes, 45.6% infectious wastes, and 2.9% sharp and pointy wastes) (14). Ashrafi (2005) reported that 1.2 and 3.14 kg/bed.day medical waste is produced by public and private hospitals in Rasht city respectively. This volume of waste was comprised of 30.1% infectious wastes, 68.09% noninfectious waste, 0.82% sharp and pointy waste, 0.99% pathologic wastes, and trivial volume of chemical and pharmaceutical wastes. Surveys carried out in Semnan and Isfahan city showed that 1.03 and 2.37 kg/bed.day wastes were produced in Semnan and Isfahan city respectively (15). A study in 2002 in Mashhad-based hospitals showed that 1.67 kg/bed.day waste is produced in these hospitals. (16)

However, the results here showed that volume of noninfectious and infectious wastes produced in the hospitals under study was 2.34 and 1.52 kg/bed.day respectively (Table 3). In the case of the psychology hospital the rate of produced infectious waste was 0.068 kg/bed.day because of absence of a surgery rooms and small extent of medical services.

It is notable that the dissected body limbs and dead embryo would be stored in proper facilities (body fridge) before being transported to graveyard and buried as per religious codes.

As listed in Table 6, only 40% of medical the educational hospitals under study had a specific waste management operation plan. Disaggregation of chemical waste in strong sacks and white/brown containers was not performed in

the hospitals and only 60% of the waste containers would be washed and disinfected after disposing of the wastes. Only 40% of the hospitals had a temporary place for stocking wastes equipped with ventilation system, sewage system, hot/cold water taps, washable floor, and roofed. In 60% of the cases, the facilities were not standard. Sewage of the hospitals was directly connected to urban sewage system and no pre-treatment operation was carried out on it.

The results showed that none of the hospitals had implemented standard procedures for disposing of chemical wastes and they were disposed of with other wastes. All the hospitals under study used non-incineration methods to disinfect medical wastes and only the psychology hospital had outsourced waste management process (Table 1). Due to high volume of produced medical waste, Imam Khomeini used two non-incineration disinfection machines (autoclave and *hydroclave Systems* that grind and disinfect the wastes by evaporating syrup of the waste). Hdydroclave machine functions at 121Cº and 1.5bar and disinfects waste in 50 min before drying out and grinding the waste. The only disadvantage of the machine is its high sensitivity to metal parts. In addition, the disposable cloths and coat labs might damage the machine by displacing its shaft. These indicate necessity of waste disaggregation at the source. Autoclave is not capable of grinding the waste and only disinfects the waste at 121 Cº and 1.5 bar in 45 min. Hydroclave machine has the advantage of reducing weight of the waste 70-80% by drying out the waste and that is does not need fireproof sacks. As the results showed, none of the medical facilities in urima city had a well-documented program to ensure quality of function and proper calibration of the machines.

Consequently, most of the waste sterilization machines needed monthly services and they are not functional 2-3day/month on average. In addition, only 60% of the personnel dealing medical waste use personal safety equipment and only 20% of the hospitals had adequate locker room, bathroom, recreational facilities specially designed for these personnel.

Volume of the waste produced in hospitals depends on many factors such as number of operational beds, educational or medical nature of the hospital, type of hospital (private, public), special services provided in the hospital, culture of the local population, the personnel and the authorities' concern about waste management, and cultural and promotional works commissioned by the managers and the authorities about waste management. Therefore, volume of produced waste in different cities and countries varies widely. Medical centers that have implemented waste disaggregation plan produce far less hazardous waste comparing with the centers that have not. Unfortunately, lack of cultural and promotional program to raise awareness about necessity of waste disaggregation plan from the source, and lack of knowledge among the managers, authorities, and supervisors, and nurses about their responsibility about

waste management contribute in volume of medical waste produced in Iranian hospitals. According to the estimates by WHO, by implementing an effective waste disaggregation plan, 80% of hospital waste would be non-hazardous (quasi-household), 15% as pathologic and infectious waste, 1% as sharp and pointy wastes, 3% as chemical and pharmaceutical waste, and less than 1% as radioactive wastes, gas capsules, broken mercury thermometers, and batteries. These estimates are inconsistent with our results.

Another factor that contributes in high volume of hospital infectious waste is the patients and their visitors' lack of knowledge about type of waste. Although blue color recycle bins (for noninfectious wastes) are available in the patients' room, the patients and their visitors are frequently seen throwing noninfectious wastes into the bins designed for infectious wastes. This action increases volume of infectious waste and costs of disinfection process. Therefore, the main issues with regard to hospital wastes are waste management at the source, collection, transportation, and disposing of the waste. It is notable that strict supervision on implementation of waste management instruction could be effective in reducing waste volume and improving waste management quality. It is worthy to note that holding educational courses for all levels of personnel including interns, residents, nurses, health assistants, service employees, and implementing infection control committee, hospital health and safety code, enforcing approvals of the committee to achieve objectives of medical waste management law are necessary and essential.

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