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HEALTHCARE WASTE SEGREGATION, TREATMENT AND DISPOSAL PRACTICE IN GOVERNMENTAL HEALTHCARE FACILITIES IN ADDIS ABABA, ETHIOPIA

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Abstract

Inadequate handling of healthcare wastes has serious public health consequences and a significant impact on the environment. The problem of how to manage healthcare wastes has become one of a critical concern in Ethiopia. This study aimed to assess the current healthcare wastes segregation, treatment and disposal practices of 32 randomly selected governmental healthcare facilities in Addis Ababa, Ethiopia. A pre-tested checklist was used to collect data and data were analyzed using SPSS version 20. Less than half 102 (42.9%) of healthcare delivery sections had safe healthcare waste segregation practice with hospitals being better as opposed to health centers (X^2=51.64, df=1, p<0.001). Using a Mann-Whitney test, the segregation practice score was significantly higher in hospitals compared to health centers (U=3227(Z= -5.584), p=0.000). Moreover, the median healthcare wastes segregation practice score significantly vary between healthcare delivery sections and between healthcare facilities with Kruskal-Wallis test (X^2(4) =87.07, p=0.000) and (X^2(31) =53.35, p=0.008) respectively. It was observed that 23(82.1%) and 26(81.2%) of incinerators and placenta pits were in poor conditions respectively. Governmental healthcare facilities healthcare waste segregation practice was minimal. Numerous deficiencies were frequent in all observed incinerators in addition indiscriminate disposal of healthcare wastes was a great concern. Hence, establishing strong healthcare waste management policy along with well organized healthcare waste management system at all levels is a far better approach to safeguard healthcare workers, patients and community from impending short and long term consequences.

Key Words: *Healthcare wastes, Segregation, Treatment, Disposal, Governmental healthcare facilities, Ethiopia*

Introduction

Healthcare facilities (HCFs) generate healthcare wastes (HCW), which are of great concern due to their potential hazard and health risks if not properly managed. Inadequate and inappropriate handling of HCW may have serious public health consequences and a significant impact on the environment. Injuries, transmission of infections, environmental pollution, fire hazards, and public nuisance are the major risks of poorly managed HCWs (Muduli and Barve, 2012; Kuroiwa *et al.*, 2004; FMoH, 2012a). Improper healthcare waste management (HCWM) can also expose healthcare workers, patients, and the community to blood-borne pathogens (FMoH, 2012a). Recent studies indicate that as much as 33 percent of Hepatitis B virus and 42 percent of Hepatitis C virus infections arise from direct or indirect exposure to infectious wastes (WHO, 2005). HCW can also contaminate bodies of water and polluting the air through emission of persistent organic pollutants like dioxins, furans, and polychlorinated biphenyls. Hence, HCW has become a significant concern for both the medical and general community (FMoH, 2012a; Patil and Shekher, 2001). Moreover, safe HCWM is a key issue to control and reduce healthcare acquired infections and reflect the quality of the services (FMoH, 2012a, FMoH, 2010).

No matter what final strategy for treatment and disposal of wastes is selected, it is critical that wastes are segregated prior to treatment and disposal (Pruss *et al.*, 1999). However, in most countries there was little or no observable capacity for management, treatment, and recycling or final disposal of hazardous wastes and mass incinerations of HCW is a common practice and create a great threat to the general public (Pruss *et al.*, 1999, John *et al.,* 2008). Although, there are several technologies for the treatment of HCW, such as incineration, autoclaving, hydroclaving, microwaving and chemical disinfection (Pruss *et al.*, 1999).

In developing countries the problem of how to manage HCW is worse than ever and the endless generation of HCW sharply raised coupled with poor management. In spite of this, management of HCW is the most neglected activity (Kuroiwa *et al.*, 2004; Abd, 2010; Rahman *et al.*, 2008; Sabiha *et al.*, 2008; Qaesar, 2012; Goodnough, 2001). In this regard, Ethiopia is not exceptional the high HCW generation rates compounded by poor handling has been a common phenomenon (Tesfahun, 2015; FMoH, 2012b; Muluken *et al.*, 2013). Studies conducted in Addis Ababa and else were in Ethiopia showed that the generation rate and proportion of HCWs significantly higher than the World Health Organization (WHO) threshold (Tesfahun *et al.*, 2014; Muluken and Abera, 2010; Debere *et al.*, 2013; Tadesse and Kumie, 2014; Samuel and Woudemagegn, 2016). Moreover, inadequate practice among healthcare workers and lack of enforced regulations attribute the current HCWM situation even poorer. Now wastes threaten the public, since the HCFs are situated in the heart of the city (Tadesse and Kumie, 2014; Debalkie and Abera, 2017). Furthermore, there were limited studies that describe the actual HCW segregation, treatment and disposal practice of governmental HCFs. Therefore, to develop reliable HCWM system critical assessment of existing HCFs waste management practice is unquestionable. Hence, the primary

objective of this study was to assess the current HCW segregation, treatment and disposal practices of governmental HCFs in Addis Ababa.

Methods

Study Area

The present study was carried out in Addis Ababa the capital city of Ethiopia. Administratively, the city is divided in to 10 Sub cities and 116 Woredas (UN-HABITAT, 2008). There were a total of 92 functional governmental health centers and 13 hospitals found under city government of Addis Ababa health bureau.

Study Design and Population

A cross-sectional study was employed to assess the current HCW segregation, treatment and disposal practice of 32 (4 hospitals and 28 health center) randomly selected governmental HCFs in Addis Ababa from February to March 2016. The sources and study populations were all healthcare delivery sections, waste treatment and disposal facilities of the selected HCFs.

Sampling Techniques and Sample Size

Stratified random sampling technique was used to select HCFs. Census was applied for all healthcare delivery sections, HCW treatment and disposal facilities. Therefore, a total of 238 healthcare delivery sections, 32 HCW treatment and 32 HCW disposal facilities were included for assessment.

Data Collection

A pre-tested structured observational checklist was used for data collection. The data collection tool was developed by referring World Health Organization (WHO) guideline and other relevant literature's (WHO, 2004; Pruss *et al.*, 1999; John *et al.,* 2008, Batterman, 2004; FMoH, 2008; FMoH, 2005). Data were collected by trained three nurses.

Data Quality

The data collection tool was tested for internal consistency (reliability) using Cronbach's Alpha and 9 HCW segregation items, 8 HCW treatment items and 7 HCW disposal items appeared to be worthy of retention resulting Cronbach's alpha of 0.978, 0.872 and 0.944 respectively.

Measurement

A scoring system was used and each correct/ acceptable practice was awarded with one point and zero if not. Score varies from 0 to 9 marks. Subsequently, HCW segregation practice were calculated and summed up to give the total score and categorize as safe and unsafe practice if it was above the mean and equal, and below the mean respectively. The same scoring procedures and percentile was used as a cut of point to evaluate status of brick incinerators and placental disposal pits as good condition if they fulfill 50% and above criteria's and otherwise not.

Statistical Analysis

Data were entered into Epi data 3.1 and analysis was performed using SPSS version 20. Descriptive statistics, such as frequency distribution, mean and percentage was computed. Chi-square test was applied; Fisher's exact test was considered when 20% or more of the cells had expected count less than 5. We also used non parametric Kruskal-Wallis and Mann-Whitney tests to compare median score. The level of statistical significance was set at $p \leq 0.05$.

Ethical Considerations

Ethical clearance was obtained from Jimma University Ethical review committee and Addis Ababa city Administration Health Bureau

Institutional Review Board. In addition, written consent was obtained from each ten sub-city health office departments and verbal consent from each HCFs administrator was obtained.

Result

Healthcare Workers and Patient Flow in the Study Healthcare Facilities

A total of 2,997 healthcare professionals work in all studied HCFs, of which 1,566 (52.25%) were from hospitals. A total of 9,762 patients sought some kind of health service daily during the study period. The mean (± Standard Deviation (SD)) of patent flow per day in selected hospitals and health centers were 617(±133.82) and 260.50(±91.35) respectively.

Healthcare Waste Segregation Practice

Table 1 shows HCW segregation practice by type of healthcare facility. As depicted, over two-third (68.5%), of areas did not segregate HCW appropriately with hospitals being better as opposed to their counterpart ($p<0.001$).

HCW segregation practice was assessed by nine items (like availability and puncture resistance safety box, on-site sharp waste segregation, position of safety box, separate waste collection container and on-site segregation of infectious and non-infectious wastes, leveled waste collection container, leveled and color coded waste containers and waste containers with cover). Based on the cut of point set mean of 4.82 ((SD) =2.89) less than half 102 (42.9%) of healthcare delivery sections had safe HCW segregation practice, with hospitals being better as opposed to health centers ($X^2=51.64$, df=1, $p<0.001$). There was also a significant difference in HCW segregation practice between different healthcare delivery sections ($p<0.001$) (Table-2).

Table 3 summarizes the mean HCW segregation score in relation to type of healthcare facility and other variables. Using a non-parametric Mann-Whitney test, the mean HCW segregation practice score was found to be statistically significantly higher in the hospitals compared to health centers (U=3227(Z=-5.584), p=0.000), and using Cohen's effect size estimation (Cohen, 1988), the difference between the hospitals and health centers groups was medium (r=-0.36). In addition, HCW segregation practice score in those healthcare delivery sections practicing mixing of wastes was statistically significantly lower than groups who do not mixed healthcare wastes (U= 135 (Z=-12.340), p=0.000), and the difference between the groups was large (r=-0.79).

A non-parametric Kruskal-Wallis test showed that there was a statistically significant difference in HCW segregation score between the healthcare delivery sections, ($X^2(4)$ =87.07, p=0.000) (Table 4). There was also a statistically significant difference in HCW segregation score between the governmental healthcare facilities, ($X^2(31)$ =53.35, p=0.008). A Kruskal-Wallis test also revealed that there was no statistically significant difference in healthcare wastes segregation score among the health centers ($X^2(27)$ =22.17, p=0.729) and hospitals ($X^2(3)$ =5.51, p=0.138).

Table 1: Association of various characteristics of healthcare waste segregation practice by category of healthcare facilities in Addis Ababa, Ethiopia, February to March, 2016.

Characteristics	Healthcare delivery sections		Total (%)	Chi-Square (X^2)	P-value
	Hospital (%)	Health center (%)			
Availability of sharp** waste collection container(n=208)*					
Yes	60(88.2)	137 (97.9)	197(94.7)		0.006‡
No	8(11.8)	3(2.1)	11(5.3)		
Presence of puncture resistance sharp waste collection container (n=208)*					
Yes	60(88.2)	137(97.9)	197(94.7)		0.006‡
No	8(11.8)	3(2.1)	11(5.3)		
Safety box full above ¾ and not timely disposed (n=208)*					
Yes	11(16.2)	36(25.7)	47(22.6)	2.38	0.123
No	57(83.8)	104(74.3)	161(77.4)		
Sharp waste segregation (n=208)*					
Yes	60(88.2)	137(97.9)	197(94.7)		0.006‡
No	8(11.8)	3(2.1)	11(5.3)		
Safety box placed at hand reached areas (n=208)*					
Yes	42(61.8)	98(70.0)	140(67.3)	1.41	0.235
No	26(38.2)	42(30.0)	68(32.7)		
Recapped or detaching needles observed (n=238)*					
Yes	1(1.4%)	8(4.8)	9(3.8)		0.289
No	69(98.6)	160(95.2)	229(96.2)		
Work environment contaminated with visible blood (n=238)*					
Yes	9(12.9)	28(16.7)	37(15.5)	0.55	0.460
No	61(87.1)	140(83.3)	201(84.5)		
Separate container for infectious and non-infectious wastes (n=238)*					
Yes	59(84.3)	45(26.8)	104(43.7)	66.40	0.000†
No	11(15.7)	123(73.2)	134(56.3)		
On-site segregation of infectious and non infectious wastes (n=238)*					
Yes	36(51.4)	39(23.2)	75(31.5)	18.23	0.000†
No	34(48.6)	129(76.8)	163(68.5)		
Correctly leveled waste containers (n=238)*					

Yes	51(72.9)	42(25.0)	93(39.1)	47.54	0.000†
No	19(27.1)	126(75.0)	145(60.9)		
Correctly leveled and color coded waste containers (n=238)*					
Yes	38(54.3)	38(22.6)	76(31.9)	22.79	0.000†
No	32(45.7)	130(77.4)	162(68.1)		
Waste containers with cover/lid (n=238)*					
Yes	36(51.4)	33(19.6)	69(29.0)	24.25	0.000†
No	34(48.6)	135(80.4)	169(71.0)		
Waste containers lined with a plastic bag (n=238)*					
Yes	36(51.4)	39(23.2)	75(31.5)	18.23	0.000†
No	34(48.6)	129(76.8)	163(68.5)		
Mixed (un-segregated) wastes observed (n=238)*					
Yes	34(48.6)	129(76.8)	163(68.5)	18.23	0.000†
No	36(51.4)	39(23.2)	75(31.5)		
Use of non- puncture resistance dust bins (n=238)*					
Yes	18(25.7)	33(19.6)	51(21.4)	1.08	0.298
No	52(74.3)	135(80.4)	187(78.6)		

*Healthcare delivery sections (Medical, Surgical, Pediatric and Gynecology and Obstetrics ward, delivery room, injection and dressing room, Operation Room (OR), Minor-OR, Laboratory unit, tuberculosis and leprosy clinic, Emergency room, Intensive care unit (ICU), Dental clinic, expanded program immunization (EPI) unit, Maternal and child health and Family planning unit, Orthopedic unit, Burn ward, Physiotherapy unit)
** Includes syringes, needles, blades, lancet, scalpel blades and others sharp items
*** Number of healthcare facilities
‡P-value for Fisher exact test significant taking p-value<0.05
† P-value for Pearson Chi-Squares significant taking p-value<0.05
df= 1

Table 2: Association of healthcare delivery section by type of facility and category of healthcare delivery sections by healthcare waste segregation practice in Addis Ababa, Ethiopia, February to March, 2016

Characteristics	HCW segregation practice status		Total (n=238) N (%)	Chi-Square (X^2)	df	P-value
	Safe (n=102) N (%)	Unsafe (n=136) N (%)				
Healthcare delivery sections by type of facility						
Hospital	55(53.9)	15(11)	70 (29.4)	51.64	1	0.000*
Health center	47(46.1)	121(89)	168(70.6)			
Category of healthcare delivery sections						
Medical, Surgical, Pediatrics, Gynecology and Obstetrics ward and Delivery Room	35(34.3)	13(9.6)	48(20.2)	57.93	4	0.000*
Injection and Dressing Room, Operation room and Minor-Operation room	14(13.7)	26(19.1)	40(16.8)			
Laboratory	25(24.5)	7(5.1)	32(13.4)			
Emergency room, Tuberculosis and leprosy clinic	9(8.8)	55(40.4)	64(26.9)			
Intensive care unit, Dental clinic, expanded program immunization (EPI) unit, Maternal and child health and Family planning unit, Orthopedic unit, Burn ward, Physiotherapy unit	19(18.6)	35(25.7)	54(22.7)			

df=degree of freedom * P-value for Pearson Chi-Squares significant taking p-value<0.05

Table 3: A Mann-Whitney test comparison of type of facility, mixing practice and use of non-sharp containers with segregation score in Addis Ababa, Ethiopia, February to March, 2016

Characteristics	N	Mean score	Z score	X^2	P-value
Healthcare delivery sections by healthcare facility					
Hospital	70	157.40	-5.584	3227.0	0.000
Health Center	168	103.71			
Mixing of HCW observed					
Yes	163	82.83	-12.340	135.0	0.000
No	75	199.20			
Use of non-sharp containers for HCW collection					
Yes	51	68.59	-6.069	2172.0	0.000
No	187	133.39			

Table 4: A Kruskal Wallis test comparison of categories of healthcare delivery sections with segregation practice score in Addis Ababa, Ethiopia, February to March, 2016

Healthcare delivery sections	N	Mean score	X^2	df	p-value
Medical, Surgical, Pediatrics, Gynecology and Obstetrics ward and Delivery Room	48	151.90	87.07	4	0.000
Injection and Dressing Room, Operation room and Minor-Operation room	40	124.98			
Laboratory	32	185.73			
Emergency room, Tuberculosis-clinic	64	62.99			
Intensive care unit, Dental clinic, Immunization and family planning unit, Orthopedic unit, Burn ward, Physiotherapy unit	54	114.37			
Mean	47.60	127.99			
SD	12.36	45.62			

df=degree of freedom SD= Standard Deviation

Healthcare Waste Treatment

Microwaving, autoclaving and use of chemical disinfection prior to HCW disposal was never been used by HCFs. Two (6.3%) HCFs use pyrolytic incinerator and majority (93.7%) of HCFs used single chamber brick incinerator, of which 26(92.8%) need some form of maintenance. In addition, 26 (92.8%) of incinerators were located near to work place (10 to 30 meter) and located within 500 meter of human settlement. All single chamber brick incinerators were evaluated based on eight evaluation criteria's (like presence of adequate air inlet door, presence of partially incinerated wastes and filled with ashes, presence of unburned wastes, incineration of plastic waste, incinerator required some form of problem related design and construction, regularity of de-ashing, presence of dipped syringes around the incinerator, incinerator having a stack height of 4 to 5 meter). The mean (SD) of brick incinerators status was 1.64 (2.26). It was found that 23(82.1%) of the HCFs incinerators do not meet at least

the four criteria's and they were in poor condition.

Healthcare Waste Disposal

All HCFs had placenta disposal pit. Status of placenta disposal pits were evaluated based on seven criteria (like water tightness, presence of tight fitting cover, cleanness of the pit mouth, secured fence, presence of vent pipe, presence of lock for filing door, any visible blood or pathological waste witnessed around the pit). The mean (SD) of the seven scores were 3.84 (1.62) and 26(81.2%) of the HCFs placental disposal pits were in poor condition. The study also reveals that 6(18.7%) of HCFs practice in-secured open pit burning of HCW. A Mann-Whitney test showed that the mean status of HCFs placental disposal pits score was found to be statistically significantly higher in the hospitals compared to health centers (U=7.000 (Z=-2.936), p=0.003) (Table 5). It is also shown that there was a significant difference between type of healthcare facility and status of placental disposal pit (p=0.000) (Table 6).

Table 5: A Mann-Whitney test comparison of type facility and status of placental disposal pit score in Addis Ababa, Ethiopia, February to March, 2016

Characteristics	N	Mean score	Z score	X^2	p-value
Type of healthcare facility					
Hospital	4	28.75	-2.936	7.000	0.003
Health Center	28	14.75			

Table 6: Association of placental disposal pit status and type facility in Addis Ababa, Ethiopia, February to March, 2016

Characteristics	Status of placental disposal pit		Total (n=32) (%)	P –value
	Good (n=6) N (%)	Poor (n=26) N (%)		
Type of healthcare facility				
Hospital	4 (66.7)	0(0.0)	4(12.5)	0.000*
Health centers	2 (33.3)	26 (100)	28(87.5)	

* Fisher's Exact Test significant at P <0.05

Discussion

In this study, majority (94.7%) of HCFs used safety boxes and 22.6% of the cases safety boxes were above ¾ levels and not timely incinerated. This result was similar with the study from North Wollo (Ethiopia) 25% (Mesele, 2008). In this regard, serious attention is crucial for timely incineration of safety boxes. One fifth, 21.4% of the healthcare delivery sections use non-puncture containers for collecting HCWs. Similar practices were reported from Bahir Dar (Ethiopia) 13.3% (Kelemua and Gebeyew, 2014) and from Istanbul (Turkey) 25% (Birpinar *et al*., 2009). The finding is alarming and signifies use of non puncture proof containers could possible exposed healthcare workers, waste handlers and patients for unnecessary accident injuries.

The present study showed that 31.5% healthcare delivery sections segregate infectious and non-infectious wastes. This finding is better than study from Nigeria (Bassey *et al.,* 2006). However, it was slightly lower than the study done by FMoH 37.1% (FMoH, 2012b). This discrepancy could be due to difference in type of HCFs and availability of HCW

collection containers. Likewise many studies reported poor segregation of HCW (Fayez *et al*., 2008; Mato and Kassenger, 1997; Batterman, 2004).It was found out 31.9% of healthcare delivery sections use leveled and color coded waste collection containers. This has positive effect on HCW segregation practice (Avier *et al*., 2014).

Almost all 93.7% of HCFs use brick incinerations. This was consistence with (FMoH, 2012b, Tadesse and Kumie, 2014), and higher than studies from Bahir Dar 26.6% (Kelemua and Gebeyew, 2014), West Gojjam 40% (Muluken and Abera, 2010), Gondar 54.5% (Muluken *et al.,* 2013) and Tabriz (Iran) 50% (Taghipour and Mosaferi, 2009). Conversely, 92.8% of incinerators need some form of maintenance. Similar deficiencies were report from different studies (FMoH, 2012b; Muluken and Abera, 2010; Muluken *et al.,* 2013). While HCW is treated to render it non-hazardous, these deficiencies can result in poor performance of the incinerator (FMoH, 2012a; Dicko *et al.,* 2000). It was witnessed that 92.8% of incinerator were located within 500 meter of human settlement. Since, small-scale incinerators unlikely to meet emission limits short-term inhalation exposures for individuals living within 500 to 700 meter is imminent (Batterman, 2004; Dicko *et al.,* 2000). Open pit burning of HCWs were practiced in 18.7% of HCFs. Comparable practices were reported by previous studies (FMoH, 2012b; Muluken and Abera, 2010; Kelemua and Gebeyew, 2014; Bassey *et al.,* 2006). There was strong recommendation not to incinerate polyvinyl chloride (halogenated materials) by WHO and FMoH (Ethiopia) (Pruss *et al*., 1999; FMoH, 2012a), since materials containing chlorine can generate dioxins and furans which are human carcinogens and have adverse health effects at extremely low doses (Peele *et al.*, 1981; WHO, 2000). However, it was witnessed that 89.2% of HCFs incinerate plastics materials. On the other hand, 93.7% of HCFs had properly constructed water tight placenta disposal pit. Which is consistent with study done by FMoH 98.6% (FMoH, 2012b) and higher than the study findings elsewhere (Muluken and Abera, 2010; Kelemua and Gebeyew, 2014).

Conclusion

Healthcare wastes segregation practices was minimal and far beyond the WHO recommendations. Numerous design and construction deficiencies were frequent in all observed incinerators. Moreover, untreated, in-secured and indiscriminate disposal of HCWs was a great concern. Overall, the current HCW segregation, treatment and disposal practices employed by governmental HCFs fall short of both WHO and National standards and found to be unsafe and risky. In order to ensure safe HCWM at all levels providing training for healthcare workers, establishing strong HCWM policy, adherence to national HCWM guideline and employ effectual HCWM system in all HCFs is a far better approach to safeguard healthcare workers, patients and community from impending short and long term consequences.

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