

Factors associated with biomedical waste management practices among healthcare personnel at Mbagathi county hospital, Nairobi Kenya

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ABSTRACT

Medical care is vital for life and health, but the waste generated from medical activities presents a problem to human health. Mbagathi county hospital generate 210-341kg infectious and highly infectious waste per day. Lack of work place guideline in many hospitals in developing countries, the implementation of biomedical waste regulations is still below the recommended threshold. This study determined factors associated with biomedical waste management practices among healthcare personnel in Mbagathi county hospital, in Nairobi Kenya. This descriptive cross sectional study used quantitative technique to gather relevant data. Purposive sampling was used to have 195 healthcare personnel as a study subject. Quantitative data were collected using structured questionnaires and analysed using Statistical Package for Social Scientists version 20. A descriptive analysis was used to summary the data and association between variable were tested using chi-square, multivariate and bivariate statistical test. P-values were considered significant at < 0.05. Among the surveyed healthcare personnel, the mean age (±SD) was 31.9 (7.5) years, (86.2%) had tertiary level education and (48.7%) were nurses. A significant voluminous of waste are generated: (96.9%) sharps, (91.3%) pharmaceutical, (90.3%) pathological, (81%) kitchen, (68.7%) incineration ash while the least produced waste reported (64.6%) radioactive wastes. Significant number of study participants (22.6%) had inadequate knowledge on biomedical waste management, with score of ≤ 50%. The nurses scored significantly more with regards to the knowledge on biomedical waste management compared to other healthcare personnel (P =0.001). 31% of study participant did not know when to seal safety bins. 28.2 %, 3.1% of the study participants disagreed and strongly disagreed respectively on management of the biomedical waste at the facility (P=0.005). Out of 195 of study participants, 6.7% had not agreed on recommended practices related to biomedical waste management at the hospital (P =0.001). Waste generated at various departments are source of infection that healthcare personnel and patient are exposed to and variation of knowledge among healthcare personnel is an indication of inadequacy as far as biomedical waste management is concerned. Periodic sensitization of staff using existing friendly channel to

convey messages, environmental and occupation health unit to be incorporated in all curriculum for early exposure so as to address concern arising from biomedical waste management in health facility.

Keywords: Biomedical waste management, Knowledge, attitude and practice, County Hospital, Capital City of Kenya.

INTRODUCTION

In the cause of reducing health problems, eliminating potential risks, and treating sick people, healthcare facilities unavoidably generates waste which itself may be hazardous to health [1]. Although only about 10%–25% of biomedical wastes is hazardous, and the remaining 75%–95% is non-hazardous, the hazardous part of the waste presents physical, chemical, and microbiological risk to the general population and healthcare personnel associated with handling, treatment, and disposal of waste [2]. These traditional estimates are not consistent for many developing countries. For instance, 25% of healthcare waste (HCW) produced in Pakistan is hazardous[3], 26.5% in Nigeria [4] and 2%–10% in other sub-Saharan Africa countries [5]. In Kenya, due to poor segregation practices, it is common to find that up to 50% of waste in some facilities is infectious [6]. Wherever, generated, a safe and reliable method for handling of biomedical waste is essential. Effective management of biomedical waste is not only a legal necessity but also a social responsibility.

Though legal provisions in Kenya such as; The National Health Care Waste Management Strategic Plan 2015 – 2020 / 2016 - 2021 [7] and An Orientation Guide for Health Care Service Providers in Healthcare Waste Management, 2015 exist to mitigate the impact of hazardous and infectious hospital waste on the community, still these provisions are yet to be fully implemented.

Studies have linked the lack of awareness about the health hazards from biomedical wastes, the absence of proper waste management, insufficient financial and human resources, and poor control of waste disposal with healthcare waste problems [8]. Further, the hazardous impact of medical waste on the public and environment is enhanced manifold if adequate and appropriate handling of these wastes is not adopted. The hospital settings, waste management affects the health of patients, the health care personnel (doctors, nurses, sanitary staff, etc.) and general public. Increasing global awareness among health professionals about the hazards and concomitant recommended biomedical waste management techniques is evident, the level of awareness in Kenya still considered unsatisfactory [9], [10]. It has emerged that appropriate knowledge about the health hazard of hospital waste, recommended methods for biomedical waste handling, and practice of safety measures are paramount toward the safe disposal of hazardous hospital waste and protection of the general population from various

eminent threats and consequences of the hazardous waste. Against this backdrop this study assessed the knowledge, attitude and practices doctors, nurses, laboratory technicians, and sanitary staff concerning biomedical waste management in Mbagathi County Hospital, the largest of its kind in Nairobi Kenya.

Materials and Methods

Study setting and design

This was a descriptive cross-sectional study design conducted among consenting healthcare personnel at Mbagathi county hospital,Nairobi County.The hospital has three hundred and ninety five healthcare personnel (Doctors, Clinician, Nurses, laboratory and sanitary staff) working at hospital.

Purposively sampling technique was used to select the sample size for this study. From this, the number of participants by cadre, was selected randomly proportional to the population size. Data was collected using questionnaires. Questionnaires were administered to doctors, nurses, laboratory technologist and sanitary staff to capture issues such as socio-demographic data, types of biomedical waste generated, on biomedical waste management. These was self-administered questionnaires. Quantitative approach was used for data analysis. Quantitative data from questionnaires was coded and entered into the computer for computation of descriptive statistics (frequency and cross tabulations), Statistical Package for Social Scientists (SPSS) version 20 was used for analysis. Chi-square test, bivariate and multivariate analysis was used to determine the associations between the study variables. P -value was considered statistically significance at < 0.05.

RESULTS

Demographic characteristic

The mean age (±SD) of the respondents was 31.9 (7.5) years ranging between 22 to 59 years. There was near equal distribution among respondents by gender; 55.4% females versus 44.6% male. The majority of the responds 45.1% were aged 31 to 40 years, 86.2% had tertiary level education, 48.7% were nurses, 46.7% got employed as a result of internal advertisement and 53.3% had worked for a period of 1 to 5 years (Table 1).

Table 1: Socio-demographic characteristics of study participants

Socio-Demographic Variables	Frequency	Percentage
Age		
Mean (± SD)	31.9	(±7.5)
Median (IQR)	30	(27-36)
Range	37	(22-59)
21-30	80	41.0
31-40	88	45.1
>41	27	13.8
Gender		
Male	87	44.6
Female	108	55.4
Education Level		
Primary	6	3.1
Secondary	21	10.8
Tertiary	168	86.2
Occupation		
Doctors	41	21.0
Clinician	22	11.3
Nursing	95	48.7
Laboratory technician	9	4.6
Sanitary staff	28	14.4
Mode of Employemnt		
Internal advertisement	91	46.7
External advertisement	81	41.5
Through friends	23	11.8
Years of service		
1 - 5	104	53.3
6 - 10	46	23.6
>11	45	23.1

Biomedical Wastes Generation

The types of waste generated by the hospital were distributed as follow; (96.9%) sharps, (91.3%) pharmaceutical, (90.3%) pathological, (81%) kitchen, (68.7%) incineration ash while the least produced waste reported (64.6%) radioactive wastes. Regarding the healthcare personnel who scored between 50-75%, majority (59.1%) were nurses, followed by 14.8% doctors, 12.2% clinicians, 7% Laboratory technicians same as 7% by sanitary staff.

Knowledge on recommended biomedical waste management

The overall score of knowledge in biomedical waste by healthcare personnel was 22 marks. Out the healthcare personnel interviewed 22.6%, 58.9% and 18.5% scored the overall knowledge of biomedical waste management of ≤ 50%, between 50-75% and ≥75% respectively.

Among the respondents 92.8%, 92.3%, 77.4%, 74.4% and 30.8% were able to categorize waste from kitchen, radioactive material, chemicals, pathological material and pharmaceutical waste, respectively. Variation were noted in the categorization of biomedical waste across healthcare personnel. Further, among the respondents 89.2%, 89.2%, 86.2%, 82.6%, 76.9%, 72.8%, 72.8%, 53.8%, 39%, 37.9% and 6.2% were able to recognize the hazardous nature of different biomedical waste paper, carton and boxes, pathological materials, body fluids, radioactive material, kitchen waste, unused medicine, dressing cotton, pressurized containers, chemicals and pharmaceutical waste respectively. Variation were noted in the recognition of the hazardous nature of biomedical waste across healthcare personnel (Table 2).

Table 2. Knowledge of biomedical waste management

Knowledge of Biomedical waste management	Health Professional						
	Overall N (%)	Doctors N (%)	Clinician N (%)	Nursing N (%)	Technician N (%)	Sanitary N (%)	P
Overall knowledge of biomedical waste (Total 20 Marks)							
≤50% Mark 11-10)	44 (22.6)	16 (36.4)	2 (2.3)	7 (15.9)	0	20 (45.5)	
50-75% Mark (10.1-15)	115 (58.9)	17 (14.8)	14 (12.2)	68 (59.1)	8 (7)	8 (7)	0.001
≥75% Mark (15.1)	36 (18.5)	8 (22.2)	7 (19.2)	20 (55.6)	2 (2.8)	0	
Knowledge in categorization of biomedical waste							
Kitchen wastes from the hospital	181 (92.8)	35 (19.3)	22 (12.2)	88 (48.6)	9 (5)	27 (14.9)	0.173
Radioactive materials	180 (92.3)	35 (19.4)	22 (12.2)	87 (48.3)	8 (4.4)	28 (15.6)	0.127
Chemicals	**151 (77.4)**	**33 (21.9)**	**18 (11.9)**	**84 (55.6)**	**7 (4.6)**	**9 (6)**	**0.031**
Pathology materials	**145 (74.4)**	**25 (17.2)**	**14 (9.7)**	**72 (49.7)**	**9 (6.2)**	**25 (17.2)**	**0.02**
Pharmaceutical	**60 (30.8)**	**19 (31.7)**	**12 (20)**	**21 (35)**	**5 (8.3)**	**3 (5)**	**0.031**
Sealing of biomedical waste disposal bin							
Halfway full	7 (3.6)	5 (71.4)	0	1 (14.3)	1 (14.3)	0	
Three quarters full	134 (68.7)	22 (16.4)	16 (11.9)	84 (62.7)	8 (6)	4 (3)	0.001
Completely full	46 (23.6)	9 (19.6)	5 (10.9)	9 (19.6)	0	23 (50)	
Dont know	8 (4.1)	5 (62.5)	1 (12.5)	1 (12.5)	0	1 (12.5)	
Recognition of hazardous biomedical waste							
Paper, cartons, boxes	174 (89.2)	35 (20.1)	19 (10.9)	87 (50)	7 (4)	26 (14.9)	0.561
Pathology materials	**174 (89.2)**	**32 (18.4)**	**18 (10.3)**	**90 (51.7)**	**8 (4.6)**	**26 (14.9)**	**0.041**
Body fluids	168 (86.2)	33 (19.6)	16 (9.5)	87 (51.8)	8 (4.8)	24 (14.3)	0.145
Radioactive materials	161 (82.6)	31 (19.3)	18 (11.2)	76 (47.2)	8 (5)	28 (17.4)	0.092
Kitchen wastes from the hospital	150 (76.9)	29 (19.3)	16 (10.7)	73 (48.7)	7 (4.7)	25 (16.7)	0.475
Unused medicines	**142 (72.8)**	**25 (17.6)**	**15 (10.6)**	**76 (53.5)**	**3 (2.1)**	**23 (16.2)**	**0.007**
Dressings cotton, plasters	**105 (53.8)**	**17 (16.2)**	**20 (19)**	**55 (52.4)**	**8 (7.6)**	**5 (4.8)**	**0.031**
Pressurized containers	**76 (39)**	**9 (11.8)**	**0**	**44 (57.9)**	**2 (2.6)**	**21 (27.6)**	**0.031**
Chemicals	**74 (37.9)**	**20 (27)**	**16 (21.6)**	**26 (35.1)**	**6 (8.1)**	**6 (8.1)**	**0.032**
Pharmaceutical	12 (6.2)	3 (25)	3 (25)	3 (25)	1 (8.3)	2 (16.7)	0.368

N - Number of personnel; % - Percentage; P - Level of Statistical significance; Bold shows statistical significance

Attitude towards biomedical waste management

Majority (24.1% strong agreement and 44.6% agreement) agreed that the hospital's healthcare personnel had recommended attitude in managing biomedical waste compared to 31.3% (28.2% disagreed and 3.1% strongly disagreed) who disagreed. The mean (± SD) 2.2 (± 0.79) and median (IQR) 2(1) of the summarized attitude Liker scaled data towards biomedical waste management further suggest consensus, that most healthcare personnel indicated agreement towards proper biomedical wastes management in the hospital. Strong agreement in existence of proper waste management across healthcare personnel ranged from none by sanitary staff to 45.5% among clinical officers (Table 3).

Table 3. Attitudes towards biomedical waste management

Variable	Attitude towards proper biomedical waste management				
	Strongly agree N (%)	Agree N (%)	Disagree N (%)	Strongly Disagree N (%)	P
Medical care workers					
Doctors	13(31.7)	13(31.7)	15(36.6)	0	
Clinician	10(45.5)	8(36.4)	4(18.2)	0	
Nursing	22(23.2)	39(41.1)	29(30.5)	5(5.3)	**0.005**
Laboratory technician	2(22.2)	5(55.6)	2(22.2)	0	
Sanitary staff	0	22(78.6)	5(17.9)	1(3.6)	
Gender					
Male	19(21.8)	42(48.3)	24(27.6)	2(2.3)	0.768
Female	28(25.9)	45(41.7)	31(28.7)	4(3.7)	

N - Number of personnel; % - Percentage; P - Level of Statistical significance; Bold shows statistical significance

Practice of biomedical waste management

The overall mean percentage score for practices related to biomedical waste management was 2811/3900 (72.1%). Among the respondents 20%, 22.6% and 57.4% scored ≤ 50%, marks, 50 to 75% marks and ≥75% marks, respectively. Nurses scored highest in all categories compared to other healthcare personnel regarding various practices related to biomedical waste management (P = 0.001) (Figure 1).

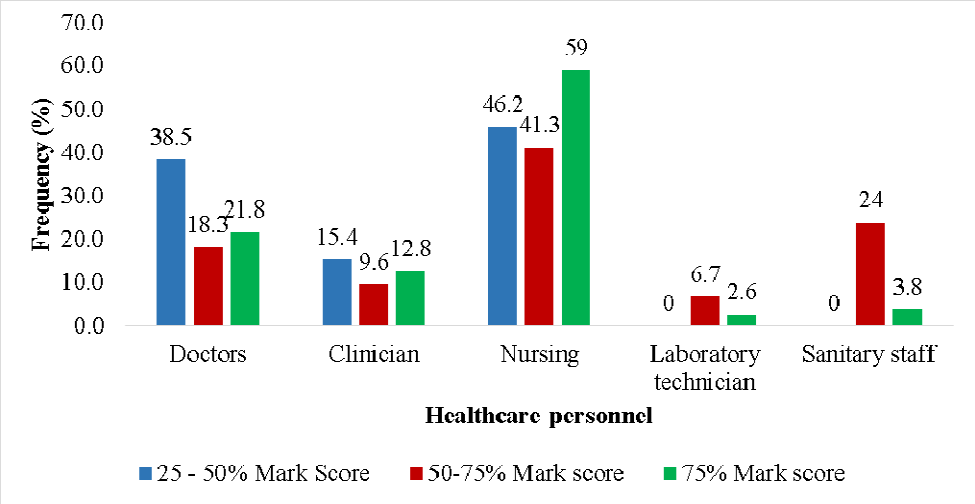

Figure 1: Overall mean percentage score for practices related of biomedical waste management among healthcare personnel

Factors associated with biomedical waste management practice

The healthcare personnel with an overall score of 50% to 75% marks was considered as practicing proper biomedical waste management. Consequently, we evaluated correlates for scoring 50% to 75% as practicing proper biomedical waste management.

Socio-demographic as a factor

In the bivariate and multivariate analysis, none of the socio-demographic factors associate with biomedical waste management (Table 4).

Types of biomedical waste generated as a factor

In bivariate analysis, recognition of kitchen waste (OR 0.3, 95% CI 0.1 to 0.7) and the recognition of incineration ash (OR 3.7, 95% CI 1.4 to 9.5) was associated with scoring 50% to 75% of adequate biomedical waste management (Table 4).

Knowledge as a factor

In bivariate analysis, the following attributes of knowledge were associated with scoring 50% to 75% of adequate biomedical waste management; knowledge on when to seal biomedical waste disposal bin (OR 0.6, 95% CI 0.4 to 0.8), categorization of chemical waste (OR 0.6, 95% CI 0.4 to 0.8) and pathological waste (OR 1.9, 95% CI 1.2 to 3.2). Further, recognition of hazardous nature of paper, cartons, boxes (OR 0.6, 95% CI 0.4 to 0.9), kitchen waste (OR 0.6, 95% CI 0.4 to 0.9), unused medicine (OR 0.6, 95% CI 0.4 to 0.9), and dressing

cotton, plasters materials (OR 0.5, 95% CI 0.3 to 0.7) were associated with scoring 50% to 75% of adequate biomedical waste management (Table 4).

Table 4: Factors associated with biomedical waste management

Socio-Demographic Variables	Total	50 to 75% Practical score of biomedical waste management		Bivariate	P
		No	%	OR (95% CI)	
Age					
21-30	80	48	60	0.01(0.09-7.5)	0.982
31-40	88	45	51.1	0.02(0.06-6.9)	0.982
>41	27	19	70.4	Reference	Reference
Gender					
Female	108	64	59.3	0.9(0.7-1.4)	0.966
Male	87	48	55.2	Reference	Reference
Education Level					
Primary	6	6	100	0.01(0.05-12.5)	0.984
Secondary	21	18	85.7	0.02(0.05-10.1)	0.984
Tertiary	168	88	52.4	Reference	Reference
Years of service					
1 - 5	104	65	62.5	0.002(0.4-1.31	0.984
6 - 10	46	21	45.7	0.001(0.05-10.1)	0.983
>11	45	26	57.8	Reference	Reference
Kitchen wastes from the hospital					
Yes	158	81	51.3	**0.3(0.1-0.7)**	**0.004**
No	37	31	85.7	Reference	Reference
Radioactive materials					
Yes	126	69	54.8	0.6(0.3-1.2)	0.187
No	69	43	62.3	Reference	Reference
Pathology materials					
Yes	176	98	55.7	1.2(0.6-2.5)	0.643
No	19	14	73.6	Reference	Reference
Incineration					
Yes	134	77	57.5	**3.7(1.4-9.5)**	**0.008**
No	61	35	57.4	Reference	Reference
Pharmaceutical					
Yes	178	97	54.5	0.8(0.4-1.5)	0.455
No	17	15	88.2	Reference	Reference
Overall Knowledge					
≤50% Score	44	38	86.4	0.008(0.06-13.2)	0.986
50-75% Score	112	72	64.3	0.006(0.04-9.8)	0.986
≥75% Score	39	2	5.1	Reference	Reference
Knowledge in categorization of biomedical waste					
Sealing of waste bin					
Yes	134	62	46.3	**0.6(0.4-0.8)**	**0.003**
No	61	50	82	Reference	Reference
Radioactive materials					
Yes	180	105	85.3	1.3(0.6-2.7)	0.568
No	15	7	46.7	Reference	Reference
Chemicals					
Yes	74	39	52.7	**0.6(0.4-0.8)**	**0.009**
No	121	73	60.3	Reference	Reference
Pathology materials					
Yes	145	95	65.5	**1.9(1.2-3.2)**	**0.013**
No	50	17	34	Reference	Reference
Pharmaceutical					
Yes	60	32	53.3	0.9(0.6-1.5)	0.614
No	135	80	59.3	Reference	Reference
Recognition of hazardous biomedical waste					
Paper, cartons, boxes					
Yes	174	93	53.4	**0.6(0.4-0.9)**	**0.037**
No	21	19	90.5	Reference	Reference
Pathology materials					
Yes	174	100	57.5	1.1(0.6-1.8)	0.985
No	21	12	57.1	Reference	Reference
Body fluids					
Yes	168	98	58.3	1.2(0.7-1.9)	0.68
No	27	14	51.9	Reference	Reference
Kitchen wastes from the hospital					
Yes	150	74	49.3	**0.6(0.4-0.9)**	**0.007**
No	45	38	84.4	Reference	Reference
Unused medicines					
Yes	142	70	49.3	**0.6(0.4-0.9)**	**0.015**
No	53	42	79.2	Reference	Reference
Dressings cotton, plasters					
Yes	105	40	38.1	**0.5(0.3-0.7)**	**0.001**
No	90	72	80	Reference	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval

Practices as a factor

These respondents' practices were associated with scoring 50% to 75% of adequate biomedical waste management; The healthcare personnel who frequently (OR 4.5, 95% CI 2.5 to 8.1), and quite often (OR 3.4, 95% CI 1.8 to 6.2) used wrong waste bins for waste segregation, storage biomedical waste (OR 0.6, 95% CI 0.4 to 0.9), communication on waste management (OR 0.5, 95% CI 0.4 to 0.8), minimization of biomedical waste(OR 0.5, 95% CI 0.4 to 0.8), disposal of pathological waste (OR 0.6, 95% CI 0.4 to 0.9), disposal of radioactive waste (OR 0.6, 95% CI 0.4 to 0.9), and disposed incineration ashes (OR 1.5, 95% CI 1.1 to 2.3) (Table 5).

Table 5. Practices of healthcare personnel in relation to biomedical waste management

Variables	Total	50 to 75% Practical score of biomedical waste management		Bivariate
		No	%	OR (95% CI)
Overall attitude towards biomedical waste management				
Strongly agree	47	15	31.9	0.6(0.2-1.7)
Agree	87	63	72.4	1.2(0.5-2.8)
Disagree	55	31	56.4	0.9(0.4-2.2)
Strongly disagree	6	3	50	Reference
Frequency using wrong biomedical waste bin				
Frequently	60	54	90	**4.5(2.5-8.1)**
Quite often	65	44	67.7	**3.4(1.8-6.2)**
Not at all	70	14	20	Reference
Risk of using wrong biomedical waste bin				
Highly risky	188	108	57.4	0.6(0.08-4.1)
Moderately risky	6	3	50	0.5(0.05-4.8)
Not risky	1	1	100	Reference
Inform biomedical waste collectors if use wrong bin				
Yes	24	15	62.5	0.8(0.6-1.2)
No	171	97	56.7	Reference
Practice proper waste storage				
Yes	96	43	44.8	**0.6(0.4-0.9)**
No	99	69	69.7	Reference
Communication on proper waste management				
Yes	144	67	46.5	**0.5(0.4-0.8)**
No	51	45	88.2	Reference
Minimize generation of biomedical waste				
Yes	157	77	49	**0.5(0.4-0.8)**
No	38	35	92.1	Reference
Proper disposal of pathological waste				
Yes	149	72	48.3	**0.6(0.4-0.8)**
No	46	40	87	Reference
Proper disposal of radioactive waste				
Yes	161	84	52.2	**0.6(0.4-0.9)**
No	34	28	82.4	Reference
Proper disposal of Kitchen waste from hospital				
Yes	172	93	54.1	0.6(0.4-1.1)
No	23	19	82.6	Reference
Proper disposal of Inceniration ashes				
Yes	53	41	77.4	**1.5(1.1-2.3)**
No	142	71	50	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval

Independent factors

In multivariate analysis; the following factors were independently associated with scoring 50% to 75% of adequate biomedical waste management: Accurate identification of the hazardous nature of dressings cotton, plasters (OR 0.5, 95% CI 0.3 to 0.8), frequent (OR 3.7, 95% CI 1.8 to 7.2), and quite often (OR 2.9, 95% CI 1.6

to 5.6) disposal of waste in the wrong waste bins and behavior change communication regarding biomedical waste management (OR 0.6, 95% CI 0.4 to 0.9) (Table 6).

Table 6: Independent factors biomedical waste management practice

Variables	Total	50 to 75% Practical score of biomedical waste management		Multivariate
		No	%	OR (95% CI)
Dressings cotton, plasters				
Yes	105	40	38.1	**0.5(0.3-0.8)**
No	90	72	80	Reference
Frequency using wrong biomedical waste bin				
Frequently	60	54	90	**3.7(1.8-7.2)**
Quite often	65	44	67.7	**2.9(1.6-5.6)**
Not at all	70	14	20	Reference
Communication on proper waste management				
Yes	144	67	46.5	**0.6(0.4-0.9)**
No	51	45	88.2	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval

DISCUSSION

The present study assessed the knowledge, attitude and practices doctors, nurses, laboratory technicians, and sanitary staff concerning biomedical waste management in Mbagathi county hospital, the largest of its kind in Nairobi Kenya. In this study waste generated in decreasing order included sharps, pharmaceutical, pathological, kitchen, incineration ash and radioactive wastes. Similar wastes generated in health facilities including cultures, stocks of infectious agents, pathological, blood and other fluids, sharps, surgery and laboratory wastes, wastes from food preparation, radioactive wastes, wastes from dialysis procedures, biological wastes, cardboard, paper documents and discarded linens[5]. It was observed that there was variation in the type and amount of biomedical waste generated depending on the month of the year [4]. Common biomedical waste generation in this order; general waste (77.5%), infectious waste (14.8) sharps (1.2%) and liquids at 3.4%. Studies show that infectious wastes, especially piercing and cutting wastes, are the main categories responsible for occupational accidents [3].

Knowledge towards Biomedical Waste Management

Our study reported more than half of the respondents scoring the overall knowledge of biomedical waste management between 50-75% with the majority (59.1%) being nurses, and least being Laboratory technicians

and sanitary staff. In Bangladesh, inadequate knowledge on biomedical waste segregation was observed more among technologists and cleaning staff than medical doctors and nurses [11]. This inadequate knowledge could be due to low level of general education and, in particular, the basic understanding regarding biomedical waste management. The first medical waste study conducted in 1989 by the Washington Department of Ecology, reported that 85% of hospitals in Washington segregated medical waste [12] and a second survey of 955 hospitals reported that 95.4% of hospitals segregated medical waste [13]. In these studies, similar to the findings of this study, nurses were more knowledgeable on management of highly infectious waste, infectious waste and toxic waste. This may be attributed to specialized training and practice of nurses. A study found that medical doctors had better knowledge than other professional groups, whereas cleaning staff had disquietingly inadequate knowledge[14].

About 69% of healthcare personnel in this study were able to segregate waste and recognized when waste bins should be sealed. In a tertiary care teaching hospital in India[15] a study showed that knowledge regarding segregation of biomedical waste was observed in approximately 90% of the health care personnel. In Thika Sub-county- Kenya[16] it was reported that over 75% of the healthcare personnel demonstrated some knowledge of waste segregation with diseases prevention, avoiding needle pricks/injury and aesthetic values as the central reasons for segregation while few named recycling. In Nigeria[5] a study showed a satisfactory knowledge of colour coding of wastes which is an essential factor for the proper segregation of waste. Proper segregation is achieved by making use of actual coloured containers or colored liners to effectively separate infectious waste from general waste. Further it was indicated that a statistically significant association between the profession of the respondents and the ability to identify the colour coding for pathological wastes with highest association amongst the nurses and this is also due to the training received. Similar situations have been reported in Iran[17] where segregation is weak and ineffective; In Nigeria[18] where infectious and non-infectious wastes are collected in the same dustbin; Botswana[21] where disposal techniques vary from one center to another. Our result similar to others in developing countries are typified by the shortcomings associated with use of infectious waste guidelines, waste segregation procedures, adoption of prevention of air pollution and appropriate waste transport.

Attitude towards Biomedical Waste Management

There were 68.7% respondents and a consensus from Liker scaled data who indicated agreement towards proper biomedical wastes management in the hospital. Majority of clinicians (45.5%) had strong agreement in existence of proper waste management and least by the laboratory technical staff. In India, a study reported good attitude

by staff towards waste management [26]. Similar to the findings of this study, doctors and clinicians had better attitude towards biomedical waste compared to laboratory and auxiliary staff. On the contrary[21] showed many doctors had the knowledge about waste management but they lacked in attitude and practice recommended for good biomedical waste management. For effective management of hospital waste, it is essential that personnel hold positive attitude towards care of the environment, occupational health and safety and teamwork. Hospital waste management has major attitudinal and behavioral components[22] .Before providing the training program, it is mandatory to understand the existing gaps and deficiencies in the study participants' knowledge, perceptions, behavior towards hospital waste management. Knowledge, attitude and practices of the personnel play an important role. Lack of these, even with good infrastructure and technology, is of little or no use in proper waste management. Knowing this, the training program can be aimed to make participants understand-environment friendly, healthy and economically viable in-house management systems, to ensure that the waste is carried responsibly from cradle to grave[20].

Practice related to Biomedical Waste Management

The 72.1% of the respondent scored 50 to 75% marks regarding practicing recommended biomedical waste management. In this study majority 73.8% had received communication about proper waste management, 90.3% had proper safety gadgets and clothing during handling biomedical waste. In agreement to our findings of this study, poor practices of waste management were reported in India, China and Bangladesh, resulting in environmental threats to the populations as well as major occupational risk[23] In Bangladesh about half of medical doctors (44.0%) and cleaning staff (56.0%) had poor practices[11]. In Pakistan studies also suggested that the practices of healthcare personnel are not up to the standards which lead to major threats of environmental pollution[24].

In this study nurses scored highest with regards to good practice related to biomedical waste management. In Bangladesh, poor practice was observed among medical doctors, technologists, and cleaning staff which is in line with a previous study[11]. Various reasons were given for the non-compliance to proper practices related to biomedical waste management including location of bins away from working area, time pressure due to too much work load, work pressure due to unexpected staff leave, casual attitude because nobody is watching you. In other studies, besides the staff, mixing of the general waste with the infectious waste was also being done by patients care givers in different areas of the hospital.

Factors associated with biomedical waste management practices

In this study, the socio-demographic factors such as age, gender, education level, occupation, mode of employment, and years of service were not associated with biomedical waste management. Similar findings were reported in Ethiopia where in the binary logistic regression analysis, sex, age, occupation, working experience, kind of health organization, salary of health care personnel and injury during health care waste management were found to be non- associated with practice towards healthcare waste[25]. This could be the fact that all the training, attention or any other required consideration for waste management are given to all staff regardless of age, gender, education level, occupation type and the years of service [26].

Various specific aspect of biomedical waste knowledge such as waste types was significantly associated with practicing recommended biomedical waste management. In Ethiopia[25] found concurring outcomes. The health personnel working department (handling non-infection and infectious waste), knowledge on healthcare waste type and knowledge on diseases transmission with healthcare waste showed statistically significant association with biomedical waste management. Several studies have reported proper biomedical waste practise associating with the knowledge on healthcare waste type and diseases transmission with the contact of infectious waste had an influence on the risk perception of healthcare workers[27].

Specific practices of biomedical waste management

In this study healthcare personnel use of biomedical waste bin, proper storage of biomedical waste, communication on biomedical waste management, handling and proper disposal of pathological, radioactive and incineration ashes were significantly associated with practicing recommended biomedical waste management. According to[28] the rational model of health promotion believed that high knowledge will translate to positive attitude and subsequently good practice though in reality, the transition is not straight forward but depended on several factors. Other studies In Nigeria[29] and in Greek [30] reported similar findings regarding proper use of waste bin, storage of biomedical waste and biomedical waste management communication as influencing the practices surrounding proper waste management.

One of the major strengths of this study was the ability to contribute to wealth of knowledge by showing the importance of knowledge, attitude and practices of the health personnel affecting the compliance rates to proper biomedical waste managements in one of the largest and busiest county referral hospital in the Capital city of Kenya. However, some of the limitation to our assessment needs to be pointed out: Firstly, cross-sectional nature of our study only allowed us to describe the compliance rates to biomedical waste managements and not a causal

conclusion. Such outcomes can be confirmed in a longitudinal study. Secondly, this study was confined to the use of the extracts from one of the Kenyan National Health Care Waste Management Strategic Plan and guidelines which could be different from those of WHO and CDC and from time to time, which could have been used during initial training in Kenya, we may not have captured the true picture of biomedical waste managements compliance. These limitations notwithstanding, our findings indicate an average knowledge, attitude and practices regarding biomedical waste management with variation among health care carders. Sufficient and frequent training using standardized national Health Care Waste Management Strategic Plan and guidelines among healthcare personnel can improve the biomedical waste management and handling practices at hospital settings.

Conclusions

- The healthcare personnel at Mbagathi County Hospital generated various biomedical waste including; sharps at 96.9%, pharmaceutical at 91.3%, pathological at 90.3%, kitchen at 81%, incineration ash 68.7% while the radioactive wastes at 64.6% was the least biomedical waste produced. These types of waste generated is the source of infection that healthcare personnel and patients are exposed to.
- In general about 59% of healthcare personnel had the knowledge of biomedical waste management and 69% of healthcare personnel were able to know when the waste bins should be sealed. Variation of knowledge is an indication of inadequacy of biomedical waste management at the source of generation.
- The overall mean percentage score for practices related to biomedical waste management was 72.1% with the majority of the healthcare personnel scoring between 50 to 75% marks. About 31% of healthcare personnel used wrong biomedical waste bin for waste disposal. The majority (73.8%) received communication about proper waste management. Nearly all the personnel (90.3%) had safety gadgets and clothing during handling biomedical waste.

Recommendations

-Periodic sensitization of staffs using existing friendly channel to convey messages, to create awareness through health education and promotion in all departments should be done using media like video and pamphlets.

-Timely collection and disposal of all types of waste should be determined and functional disposal unit should be available to effectively minimized spread of infection from waste.

- Environmental and occupation health units to incorporate the ever changing needs in curriculums in all training institutions for early exposure in order gain skills and knowledge to address the concern arising from biomedical waste management in health facilities.

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Author's Contribution

SMA, GK and JM conceived the study. SMA collected and analyzed the data and prepared the draft manuscript. GK and JM provided guidance and mentorship during the implementation of the study. All authors reviewed and approved the final manuscript.

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