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Assessment of Health Care Waste Generation, Its Characterization and Management Practice in Health Centers of Nifas Silk Lafto Sub-City, Addis Ababa, Ethiopia.

By: Biruk Birhane (BSc.)

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Acronyms and Abbreviations

BMW	Biomedical waste
BMWM	Biomedical waste management
FMHACA	Food, medicine, health care association and control administration
HCF	Health care facility
HC	Health center
HFs	Health facilities
HCFWM	Health care facility waste management
HCFWG	Health care facility waste generation
HCW	Health care waste
HCWM	Health care waste management
HCWMS	Health care waste management system
HCWGR	Health care waste generation rate
HPs	Health professionals
HW	Hazardous waste
MW	Medical waste
Non-HW	Non Hazardous waste
NSL	Nifas Silk Lafto
PF	Patient flow
WHO	World health organization
W	Woreda

Abstract

Background: The health care waste generation rate highly varies among health providers due to factors such as the number of patient flow, size of the facility, types of facility, and service. There is no effective health care waste management practice in most less developed countries including Ethiopia. There is lack of research which elaborated more detail the main cause of high proportion of hazardous wastes generation in comparission to general waste, and mean waste generation per patient flow in studied health facility.

Objective: To assess health care waste generation rate, its characterization and management practice in health centers of Nifas Silk Lafto Sub-city, Addis Ababa.

Methods: Cross-sectional study was conducted from June to July 2020. Ten health centers from Nifas Silk Lafto Sub-city were selected purposely due to poor waste management, lack of adequate knowledge and commitment within the community and health provider. Data was collected by FMHACA Environmental health professionals using observational checklist and weight scale for period of 7 consecutive days from june 15- 21/2020. Training, pre-test, and instrument calibration were used to manage data quality. Collected data was organized and entered in Epi data version 7 and cleaning was done to avoid missing values, outliers, and other inconsistencies. Cleaned data then exported into SPSS version 20 for analysis and One way ANOVA test was done.

Results: The daily mean(±SD) healthcare waste generation rate was 5.51±1.455kg/day, which was equivalent to 0.074±.016kg/pat/day. Out of the total waste generated (27.40%) was general and (72.60%) was hazardous waste. Most generation was from OPD, which was 72.3kg/week (18.76%).The proportion of sharps (32.02%), infectious (38.85%), pathological (8.18%), pharmaceutical (20.94%) and general waste (27.4%). Healthcare waste generation rate varies by number of patient flow with($p<0.001$).Nine in10 health centers were practicing healthcare waste segregation at the point of generation with number of limitations. All health centers used locally built brick incinerator as a final disposal with some functionality.

Conclusion: The mean waste generation rate per patient flow per health center was relatively higher than similar study of on-line publication.There was lack of appropriate waste segregation with different waste catagories at point of generation by most of health centers.

Keywords: healthcare waste, healthcare waste management, waste generation and hazardous waste.

Introduction

Background

Healthcare waste is medical waste which encompasses both hazardous and non-hazardous waste. Out of the total waste, 85% is non-hazardous waste and the rest 15% is hazardous waste(1, 2). Evidence from the WHO report showed that out of the total health care waste 10-25% considered as hazardous waste, however, evidence from a different kind of literature indicated that the proportion of these HW is varied from country to country and from health facility to health facility with a range of 20-75% including Ethiopia. Today much-related terms are used instead of healthcare wastes, Such as clinical waste, infectious waste, medical waste, and biomedical waste; amongest all these, Biomedical waste is the most used medical term in the majority of literature(3, 4).

The HCWs that are mainly generated from different types of healthcare establishments such as; hospitals, health centers, clinics, pharmacies, and laboratories are some examples of generators of healthcare wastes(5, 6). These waste products are materials from used needles, human body parts, sharps, diagnostic samples, pharmaceutical and so on(7, 8).

Unethical or illegal waste handling activity in the HCFs more affects susceptible individuals like waste handlers, patients, health professionals, staff members, and the surrounding society for infection and other health-related problems(9, 10). In addition to this, it assured that can cause harms on environmental condition(11).

Today, giving of low attention and less use of technology for health care waste management extremely causing the production of highly toxic wastes and which have become a serious problem, especially in Africa, particularly in most under developed and in developing countries including Ethiopia(12, 13).

Accordingly, inadequate information, lack of awareness and motivation among the waste handlers and each HCFs contributing more to the poor HCWMS. As a result of these problems, mostly in many developing countries wastes are disposed of in appropriately here and there and also infectious waste is mixed with non-HW illegally(14, 15).

In most of the HCFs, there is a lack of HCWM guidelines, an appropriate treatment system, and a disposal mechanism. Currently, much evidences showed that HCWMP in Africa continent is still inadequate. These all are the main challenges in the management of healthcare wastes(16, 17). Generally, due to inappropriate waste handling, the prevailing waste handlers and healthcare professionals(HCPs), are highly at risk of surviving in a good health condition(18, 19).

Statement of the problem

The first gap which was about lack of research which elaborated more detail on the main cause of high proportion of hazardous waste generation in comparission to general waste and the mean waste generation per patient flow per health center in studied health facility(3-27).

The second gap has been identified was there was no effective health care waste management practice in most less developed countries including Ethiopia(3-27).

The third gap has been identified was lack of temporal analysis involving on healthcare waste generation variation occurred during disease outbreak or pandemic period(3-27).

Significance of the study

This study will give more information and evidence to HCFs managers, health professionals, other staff members and policy makers on the actual picture of HCF healthcare waste generation rate, its characterization, the status of waste management practice, and its major challenges. It will be supporting and enhance HCFs for well-organized institutional-based planning, designing, budgeting, and implementing of HCWM procedures to be economical, effective, and efficient through system improvements as early as in the planning stage. Besides, used as baseline data for future studies in this area.

Literature Review

This part of the review literature is relevant to the study. The main focus of the study is on the assessment of health care waste generation rate, its characterization, and management practice in health centers of Nifas Silk Lafto Sub-city Addis Ababa, Ethiopia. Thus, the effect of each variable suggested by different authors was discussed in this part.

Health care facility waste generation

Unit generation rate: The mean(±SD) daily healthcare waste generation rate per health center from studied HCs of Addis Ababa, Ethiopia, 2014, West Gojjam Zone, Amhara Region, Ethiopia, 2010, Bench Maji Zone, 2018 and Adama, Ethiopia, 2016 was 9.61±3.28kg/day, 1.79±0.54kg/day, 2.716±0.736kg/day and 4.46±0.45kg/day respectively. Generally the study done in the health centers of Addis Ababa, Ethiopia, 2014 had the highest mean daily healthcare waste generation per health center, which was (9.61±3.28 kg//day) while the least was in health centers of west Gojjam, Ethiopia, which was (1.79 ± 0.54 kg/day) respectively(25,26, 28).

Daily average patient flow in the studied health centers: In the health center of Adama, Ethiopia, 2016 found that the daily average outpatient flow of all health centers was 171 patients per day which range from 160-185 patients. For example, the outpatient flow per day for Adama, Biftu, Bokushenen, and Geda health center was (185, 160, 170, and 168), respectively(25). Generally, the higher daily average patient flow was found in HCs of Addis Ababa, Ethiopia, which was (3,149)(27).

Daily average waste generation rate per patient flow in the studied health centers: The daily average waste generation rate per Patient flow per health center from the studied HCs of Bench Maji Zone, 2018 and Adama, 2016, Ethiopia ranged from (0.015-0.03kg/patient/day), Generally,the largest daily average waste generation per patient flow per health center was (0.03kg/patient/day) in the HC of Adama while the lowest ratio was (0.0152 kg/patient/day) in Sheybench HC of Bench Maji Zone, Ethiopia, 2018(24, 25).

Healthcare waste characterization

Table 1: Healthcare waste generation proportion in Assessed Health Centers

S.no	Title of the study	Type of HCF	Total generation per week in all HCs (kg/week)	Total Hazardous waste per week in all HCs(kg/wk)	Total non-hazardous per week in all HCs (kg/wk)(%)	Mean daily HCW generation per HC (kg/day)
1	HCWgeneration and management practice in HCs of Addis Ababa, Ethiopia, 2014 (27).	HC	672.62	413.66, (61.5%)	258.96, (38.5%)	9.61±3.28 kg/day
2	HCWgeneration and its management system: the case of HCs in West Gojjam Zone, Amhara Region, Ethiopia, 2010(26).	HC	143.44	68.85, (48%)	74.59, (52%)	1.79±0.54 kg/day
3	Assessment of HCW generation Rate and Its Management System in HCs of Bench Maji Zone**,** Ethiopia, 2017(24).	HC	109.01	45.89, (42.1%)	63.12, (57.9%)	2.716±0.736 kg/day
4	HCWgenerationand Management in HCFs in Adama ,Ethiopia, 2016(25).	HC	125.2	93.52, (74.7%)	31.68, (25.3%)	4.46±0.45 kg/day

As shown in Table 1, the study done in health centers of Addis Ababa, Ethiopia, 2014 and Adama, Ethiopia, 2016 showed that increased amount of total HCWs were produced when comparing to the study done in HCs of West Gojjam Zone, Ethiopia, 2010, in HCs of Bench Maji Zone, Ethiopia 2018(24-27). For example, in HCs of Addis Ababa and Adama, Ethiopia, more than half (61.5% & 7$_4$.7%) of the total HCW produced in all studied HCs were Hazardous waste, and the rest (38.5% & 25.3%) was a non-Hazardous waste(25, 27). On the contrary, in the study done in HCs of West Gojjam Zone and Bench Maji Zone, Ethiopia, less than half (42.1% & 48%) of the total HCW produced in all studied HCs was Hazardous waste, and the rest(57.9% & 52%) was non-Hazardous waste respectively(24, 26).

Generally, the study carried out in HCs of Addis Ababa, Ethiopia, 2014 and in Adama, Ethiopia, 2016 showed that relatively produced higher amount of HW which was (61.5% & 74.7%) comparing to the study done in HCs of Bench Maji Zone, Ethiopia, 2018 and West Gojjam Zone, Amhara Region, Ethiopia, which was (42.1% & 48%) respectively.

Table 2: Healthcare waste generation rate by health service delivery sections

Name of HC	Delivery ward	Pharmacy	Emergency	Laboratory, VCT & ART	MPH, FP & EPI	OPD & Ward	Injection & dressing	TB
Addis Ababa HC	38.6± 2.03 (42.2%)	12.40± 0.65 (13.%)	12.41± 0.16 (13.%	15.18± 0.75 (16.58%)	8.0± 0 .36 (8.7%)	3.03± 0.15 (3%)	------	1.93± 0.140 (2.1%)
West Gojjm Zone HC	0.35± 0.26 (19.5%)	0.436± 0.209 (24.%)	------	0.091± 0.05 (5.09%)	0.208± 0.09 (11.6%)	0.105± 0.08 (5.87%)	0.59± 0.14 (33.3%)	0.00± 0.007 (0.3%)
Bench Maji Zone HC	0.674± 0.23 (72%)	------	------	------	------	-----	-----	0.262± 0.071 (28%)
Adama HC	7.49 (39.6%),	1.81 (10.1%)	------	3.71 (20.72%)	1.49 (8.29%)	1.93 (10.76%)	1.89 (10.52%)	-----

As shown in Table 2, the highest amount of HCWs were generated in the delivery ward of Addis Ababa, Ethiopia, 2014, in Adama, Ethiopia, 2016 and Bench Maji Zone, Ethiopia, 2018, which was 42.2%, 39.6% and 72% with a mean(±SD), of 38.6±2.03kg/day, 0.749±0.26kg/day and 0.674±0.23kg/day respectively. There was also the highest amount of HCWs were generated from injection & dressing room of West Gojjam Zone, which was 0.59±0.14 kg/day(33.3%). Whereas, TB follow-up room contributed the lowest portion to the total HCW generated in West Gojjam Zone and Addis Ababa, which accounted for (0.39%) with a mean(±SD), of 0.007±0.007kg/day and (2.1%) with a mean(±SD), of 1.93±0.140 kg/day respectively(24-27).

In general, the highest amount of HCWs were generated in the delivery ward of Addis Ababa, Ethiopia, which was(42.2%) with a mean (±SD), of 38.6±2.03 kg/day, while the least amount was recorded in the TB follow-up room of West Gojjam Zone, which accounted (0.39%) with a mean (±SD), of 0.007±0.007kg/day(24, 26, 27).

Table 3: Healthcare waste generation rate proportion by hazardous waste type in assessed health centers

Name of HCs	Sharps	Infectious	Pathological	Pharmaceutical	Total
Addis Ababa HC	0.87±0.28 kg/day (14.57%)	2.2±0.84 kg/day (38.36%)	2.8±1.4 kg/day (47.07%)	-------	5.97±2.31 kg/day (61.5%)
West Gojjam Zone HC	0.34±0.1 kg/day (39.2%)	0.17±0.04 kg/day (19.64%)	0.34±0.25 kg/day (39.2%)	0.017±0.01 kg/ day (1.96 %)	0.86±0.33 kg/day (48%)
Bench MajiZone HC	0.267±0.107 kg/day (23.3%)	0.2695±0.124 kg/day (23.6%	0.441±0.157 kg/day (38.6%)	0.166±0.058 kg/day (14.5%)	1.144±0.34 kg/day (42%)
Adama HC	0.24±0.20 kg/day(9.24%)	0.57±0.81 kg/day(22.3%)	0.59±0.39 kg/day(22.8%)	0.52±1.08 kg/day(20.40%)	3.34±0.42 kg/day(74.%)
Northern Palestine HC	(3%)	(35%)	(38%)	(24%)	--------

As shown in Table 3, Generally, the highest hazardous waste were generated from the health centers of Addis Ababa, Ethiopia, with mean(±SD) generation rate(5.97±2.31kg/day), of which sharps{0.87±0.28 kg/day(14.57%)}, infectious{2.2±0.84(38.36%)} and Pathological waste{2.8±1.4(47.07%)} and cumulatively pathological waste were highly produced HW which was 7.4kg/day(37.15%) when compare to other wastes(24-28).

Health care facility waste management practice

A study conducted in the health center of Addis Ababa, Ethiopia 2014 showed that half or 5 of health centers segregate waste at the source of generation. However, a similar study done in the health centers of Bench Maji Zone, Ethiopia 2018 showed that only two (2), out of 10 health centers segregated wastes at the source of generation(24, 27). Whereas, in Adama none of the health centers segregated wastes at the source of generation(25).

Another study done in HCs of Jenin district northern part of the West Bank in Palestine,2008 found that 27.5% HCs had regulations that enforce the segregation of HCW(28).

A study done in health centers of Jenin district northern part of the West Bank in Palestine,2008 showed that (96.1%) of health centers used separate color containers for the collection of HW and non-HW. Whereas, in the health centers of Addis Ababa, Ethiopia, 2014 found that, only half or 5 of health centers used separate containers for the collection of these two wastes (27, 28). However, a similar study done in health centers of West Gojjam Zone, Amhara region, Ethiopia, 2010 and in the health center of Adama, Ethiopia 2016, showed that on the contrary, almost all of the HCs had no separate containers for the collection of hazardous and non-HW, and almost in all of the health centers these two wastes are mixed each other's(25, 26).

In another way, in health centers of Jenin district northern part of the West Bank in Palestine, 2008 showed that only (21.2%) of containers had warning signals on Containers(28). In addition to this, 27.5% of health centers collect HW at the end of each workday(28).

A study conducted in health centers of Addis Ababa, Ethiopia, 2014, West Gojjam Zone, Amhara Region, Ethiopia, 2010, in Bench Maji Zone Ethiopia, 2018 and Adama, Ethiopia, 2016, showed that all HC used an open bucket for the transportation of healthcare wastes to the disposal site. Whereas, most of the devices used for transportation were unprotected and a majority of HCs waste storage was not comfortable for waste handlers to perform their daily activity(24-27). Generally (80%) studied HCs had no separate temporary storage place for storing wastes, had no known program to collect wastes from different service sections, and wastes were not being transported to disposal site by the skilled waste handlers(24-27).

According to the study conducted in HCs of Addis Ababa, Ethiopia 2014, in HCs of West Gojjam Zone, Amhara Region, Ethiopia 2010, in HCs of Bench Maji Zone Ethiopia 2018 and HC of Adama, Ethiopia 2016 showed that none of HCs were treated HCW and collection equipment(24-27). Whereas, a study done in HCs of Jenin district northern part of the West Bank in Palestine, 2008 found that (69.5%) of HCW was treated before disposed (28).

The study done in health centers of Addis Ababa,Ethiopia, 2014 showed that all or 10 of health centers used locally built bricks incineration as a final disposal system. 3 out of 10 health centers, placenta pits have not fulfilled the standard of WHO(27). Another study carried out in health centers of Jenin district northern part of the West Bank in Palestine, 2008 found that (60.8%) of health centers used incineration as final disposal(28).

However, in health centers of West Gojjam Zone, Amhara Region, Ethiopia 2010, in health centers of Bench Maji Zone Ethiopia 2018 and in health centers of Adama, Ethiopia, 2016, more than half (>50%) health centers used local built bricks incineration without proper protection to the surrounding, worn-out chimneys or without chimneys, most of the incinerators lack covers for waste feeding and ashes removing door(24-26). And some HCFs had no current standard operating procedures for the burning of HCWs in both studies respectively(26, 27).

Conceptual framework of factors determining health facility waste generation

Based on the reviewed so far, healthcare waste generation rates can be affected directly by the number of patients, Disease outbreak, Waste management practice, Resources of health centers, Type of unit section of the health facility (OPD, delivery, etc.), and Seasonality.

Besides, healthcare waste generation rates can be also affected by the general condition of the area where the health care facilities ares situated, severity of disease, technology used, economic, cultural, social and environmental factors. These are briefly expressed in the following conceptual framework(3-6, 8).

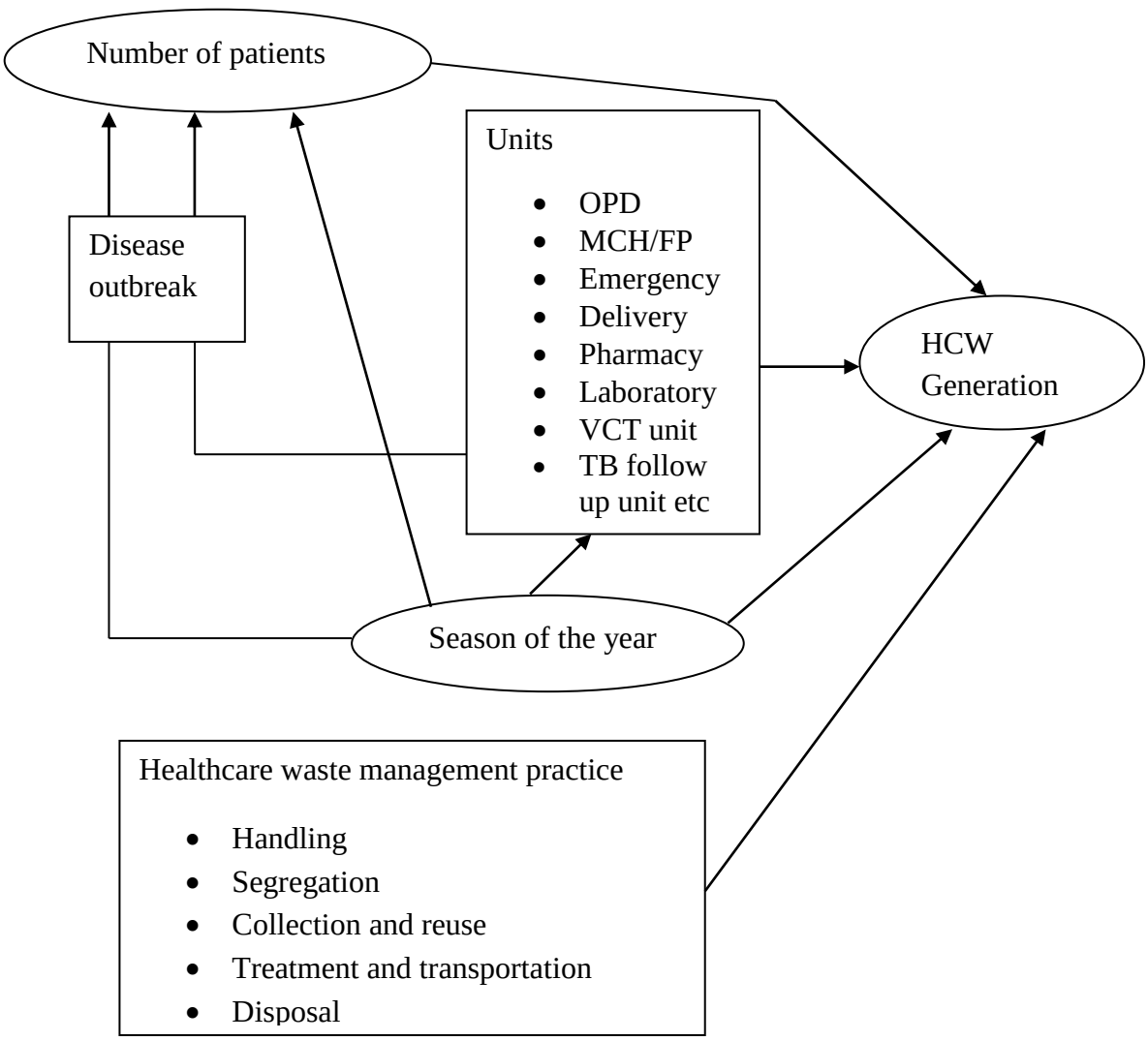

Figure 1: Factors that determine HCW generation in health facility, Ethiopia, 2014(29).

Objective

General Objective

To assess health care waste generation rate, its characterization and management practice in health centers of Nifasilk Lafto Sub-city, Addis Ababa, Ethiopia, 2020.

Specific Objectives

1. To measure health centers' waste generation rate.
2. To describe health centers' waste characterization.
3. To assess health centers’ waste management practice.

Methods

Study Area and Period

This study was conducted from June to July 2020, in Nifasilk Lafto sub-city governmental health centers, Addis Ababa, Ethiopia. The total population of the sub-city is 405,380, of which 53% are females and 47% are males. There are 11 Governmental Health centers and 27 private clinics which are functional in the sub-city. In general, the healthcare waste management practice of this sub-city was poor due to less use of technology, lack of adequate knowledge within the community and health providers. For instance, in most part of the sub-city near to or around the health facilities, health care waste were seen in a dispersed way and HCFs use incineration which was not well protected and function.

Study Design

Institution-based quantitative cross-sectional study was conducted to assess health care waste generation rate, its characterization, and waste management practice in health centers.

Source population

All governmental health centers are found in Nifasilk Lafto sub-city, Addis Ababa.

Study population

10 selected health centers from Nifasilk Lafto sub-city, Addis Ababa.

Inclusion Criteria

All health centers in the Nifasilk Lafto sub-city were included.

Sample size determination

1. For specific Objective one [HCWs generation rate]

Based on the study conducted in health centers of Addis Ababa, Ethiopia, in 2014, the mean generation rate of healthcare waste was found to be 9.61kg/day, with SD = 3.28kg/day (27).

Based on a study finding, the sample size was calculated using a single population mean formula, $\mathbf{n= \frac{(Z_{\alpha/2})^2 \times \delta^2}{(d^2)}}$

Where,

n=sample size to be determined

δ=population standard deviation (SD), estimated by sample Standard Error (SE)

Zα/2= Level of statistical significance 1.96 at a confidence level of 95%

d=margin of error corresponding 95% of certainty

d=(Zα/2) x SE, SE=SD/√n=1.04,

=1.96*1.04=2.04.

Therefore, 2.04 of 9.61=10% [i.e within 10% from 9.61]

2. For specific objective two [HCWs characterization]

Based on the study conducted in the health centers of Adama, Ethiopia, 2016, the mean generation rate of healthcare waste was found to be 4.46kg/day, with SD=0.45 kg/day(25).

Based on a study finding, the sample size was calculated using a single population mean formula, $\mathbf{n= \frac{(Z_{\alpha/2})^2 \times \delta^2}{(d^2)}}$

Where,

n=sample size to be determined

δ=population standard deviation (SD), estimated by sample Standard Error (SE)

Zα/2 = Level of statistical significance 1.96 at confidence level of 95%

d=margin of error corresponding 95% of certainty

d=(Zα/2) x SE, SE=SD/√n=0.23,

=1.96*0.23=0.45.

Therefore, 0.45 of 4.46=10% [i.e within 10% from 4.46]

3. For specific Objective three[HCWs management]

Based on the study conducted in the health centers of Bench MajiZone**.**Ethiopia, 2018, the mean generation rate of healthcare waste was found to be 2.716kg/day, with SD= 0.736kg/day (24).

Based on a study finding, the sample size was calculated using a single population mean formula, $\mathbf{n= \frac{(Z_{\alpha/2})^2 \times \delta^2}{(d^2)}}$

Where,

n=sample size to be determined

δ=population standard deviation (SD), estimated by sample Standard Error (SE)

Zα/2 = Level of statistical significance 1.96 at confidence level of 95%

d=margin of error corresponding 95% of certainty

d=(Zα/2) x SE, SE=SD/√n=0.233,

=1.96*0.233=0.46.

Therefore, 0.46 of 2.716=10% [i.e within 10% from 2.716]

Table 4: Assumption and given used for sample size calculation 2014(27).

%of mean	d	(Zα/2)	$(Z\alpha/2)^2$	SD	SD^2	d^2	n
2.5%	5.27	1.96	3.8416	5.02	25.2004	27.7	3.5
5%	4.03	1.96	3.8416	5.02	25.2004	16.2	6.0
7%	3.43	1.96	3.8416	5.02	25.2004	11.76	8.23
10%	2.82	1.96	3.8416	5.02	25.2004	7.95	10.12

Based on the above calculation 10% precision of mean, ten [10] health centers were selected for specific objectives one, two and three.

Therefore, the final sample size was the largest number which was 10 for this study.

Sampling Procedure

Nifasilk Lafto sub-city was purposely selected because, healthcare waste management practice in this sub-city was poor due to less use of technology, lack of adequate knowledge and commitment within the community and health providers. For instance, in most parts of the sub-city near to or around the healthcare facilities, wastes were seen in a dispersed way and use incinerator which was not well protected and function.

Data collection

Data collectiontools

1. Observational checklists: It was used for assessing the health care waste management systemin each health center, such as waste segregation, collection, temporary waste storage, transportation, treatment, and disposal. All data collection instruments were pre-tested in NSL sub-city woreda 10 health center and modification was done accordingly.

2. Golden Lark weight measurement scale: This standard weighing scale was used to quantify health centers' waste generation rate in each health center for seven consecutive days. Weighing scales were calibrated every morning in the FMHACA office using a 2kg weight before the actual measurements started in the field, and daily on-site supervision was made by the supervisors during the actual measurements. To determine the waste generated with different categories like general, sharp, infectious, pharmacological and pathological waste with safety boxes and plastic bags of different colors and labeling were used according to WHO guidelines. The weighing scale was pre-tested in NSL sub-city woreda 10 health center and modification was done accordingly.

Data collection procedure

Data collection checklists were first I prepared in English and translated to Amharic, and all data collection tools were pre-tested in 10% of the selected HCs and modification was done accordingly. Data was collected by Nifasilk Lafto sub-city FMHACA Environmental health professionals using Observational checklists and Golden Lark weight measurement scale for a period of 7 consecutive days. On the first day, before the data collection was conducted, a brief explanation was given to the head of the medical director about the purpose of the study. Then, the HCW management system, such as waste segregation, collection, temporary waste storage, transportation, treatment, and disposal was assessed in each health center using an observational checklists on june 15/2020 morning from 2 to 5 local time. Health centers' waste generation rate was measured by using a measuring scale and weighed with photos by data collectors in each of seven consecutive days from june 15-21/2020 either morning from 2:00-5:00 or afternoon time from 8:00-11:00 local time, depends on the HCs waste collection program. Health care waste composition was separately collected and labeled with information on its source, and recorded mostly at the end of the workday which was facilitated by cleaning personnel. The weight obtained from measuring HCWs was quantified and recorded by weight, in kg/day and weighed at the generation point to quantify waste being generated on specified delivery units.

Variables

Dependent variable

- ✓ Waste generation rate.

Independent Variable (Just for descriptive)

- ✓ Materials used for waste segregation, storage, collection, transportation, treatment, and disposal.
- ✓ Number of patients
- ✓ Type of service sections (delivery, ward, etc.)

Operational definitions

Health care waste: All wastes such as general, sharp, infectious, pharmacological and pathological wastes generated from 10 selected health centers.

Health care waste generation: The amount of wastegenerated from 10 selected health centers for a period of 7 consecutive days from june 15-21/2020.

Waste management practice: The activities performed in 10 of health centers to manage waste from its point of generation to final disposal incinerator.

Hazardous waste: Includes sharp, infectious, pharmacological and pathological wastes generated from studied health centers.

Non-hazardous waste: wastes that has not been infected. E.g. general office waste, packaging, or left over food in health centers.

Sharps waste: Used and unused sharps (e.g. needles, syringes, and blades) from studied health centers.

Pathological waste: Include human body parts, and fetuses in health centers.

Segregation: It's separation of HCW into general, sharps, infectious, pharmacological and pathological wastes from 10 selected health centers.

Infectious waste: Waste suspected to contain pathogens (e.g. waste contaminated with Blood & other body fluids; laboratory cultures & microbiological waste) in health centers.

Data quality assurance

Weighing scales were calibrated every morning in the FMHACA office using a 2kg weight before the actual measurements started in the field. Daily on-site supervision was made by the supervisors during the actual measurements. Finally, the completeness of all activities was rechecked, assured, and compiled by supervisors just after the completeness of data collection activities at the end of the day. Data quality was assured by using different techniques. Before data collection, two days of training was given to the data collectors and supervisors on data collection tools and waste measurements technique to fill the checklists properly and to reduce error. Instruments were pre-tested in NSL sub city woreda10 health center to check the functionality or effectivity of data collection tools and performance of data collectors. Based on the findings of the pilot study remodification of the data collection tools was done quickly. All the information obtained from data collectors was checked, assured, and given feedback in each of seven consecutive days by the supervisor at the field during the data collection period, by conducted supportive supervision.

Data management

All the information obtained from health centers were recorded on checklists in each of seven consecutive days by data collectors at the field during the data collection period and checked its completeness by supervisors. Collected data was organized, compiled and entered in Epi data version 7, and cleaning was done to avoid missing values, outliers, and other inconsistencies. Then cleaned data was exported from excel to SPSS version 20 for analysis.

Data analysis

Data analysis for specific objective one (healthcare waste generation rate) which was obtained from a standard weighing scale was described using mean, Standard Deviation (SD), and table.

Data analysis for specific objective two (healthcare waste characterization) the proportion of waste type generation which was obtained from a standard weighing scale was described using mean, Standard Deviation (SD), percentage and table.

Data analysis for specific objective three (healthcare waste management) which was obtained from observational checklists was described using percentage and frequency. One-way ANOVA test was conducted to described healthcare waste generation rate viration by number of patient flow.

Ethical considerations

The study was conducted after having an ethical clearance from the Review Board of Addis Ababa University College of Health Science. Additional clearance was obtained from Addis Ababa Regional Health Bureau, Public Health Research, and Emergency Management Directorate. Before performing the procedure, verbal and written consent was obtained from each health center, and issues of rights, privacy, and confidentiality were ensured during the data collection period.

Dissemination of the results

The resuls of this study will be submitted to Addis Ababa University, college of health sciences, school of Public Health, and Nifasilk Lafto Sub city health office and each health centers. Finally, the findings will be prepared for possible publication.

Results

General description of the health centers and departments: The type of departments under ten health centers were OPD, Pharmacy, Lab, VCT & ART, Injection and dressing, MCH, FP and EPI room, TB follow-up Unit, Delivery ward, and Emergency.

Assessment of Healthcare Waste Generation Rate

Unit generation rate: The mean(±SD) daily healthcare waste generation rate per health center was 5.51±1.455kg/day, of which, 1.51±.092kg/day(27.4%) was general and 3.99±1.445(72.6%) was hazardous waste. The highest amount of healthcare waste per day was generated at Woreda 3 health center, which was 7.44kg/day (13.51%) while the least amount of healthcare waste was recorded at Woreda 2 health center, which was 3.24kg/day(5.88 %)(Table6).

Patient flow in studied health centers and service sections: The mean patient flow per day in health centers and at OPD was 74.20±10.549 and 17.80±2.658kg/day, respectively. More patients were visited in Woreda 03 health center, which was 644 and on the other hand, a fewer number of patients were found in Woreda 02 health center, which was 420 patients(Table 5).

Healthcare waste generation rate per patient flow per day per health center: The mean daily HCW generation rate per patient flow per health center in studied health centers were 0.074±.016kg/pat/day. Among studied health centers, Woreda 10 health center generated the largest daily mean waste generation rate per patient flow per health center, which was 0.097kg/patient/day while the lowest ratio of healthcare waste per patient flow per day, was found in Woreda 02 Health Center, which was 0.054kg/patient/day(Table 5)..

Table 5: Unit generation rate and healthcare waste generation per patient flow per day in the studied health centers of NSL sub-city, Ethiopia, 2020

S.no	Name of HC	PF per 7 day per HC	PF per 7 day at OPD	Mean PF per day at OPD	PF per day per HC	Daily HCWG per day per HC	Mean daily HCWG per PF per HC (kg/pat/day)
1	W1 HC	609	146	21	87	6.94	0.08
2	W2 HC	420	102	14	60	3.24	0.054
3	W3 HC	644	155	22	92	7.44	0.081
4	W4 HC	476	114	16	68	6.33	0.093
5	W5 HC	441	105	15	63	5.13	0.081
6	W6 HC	546	131	19	78	4.73	0.061
7	W9 HC	581	139	20	83	6.66	0.08
8	W10 HC	469	113	16	67	6.46	0.097
9	W11 HC	497	119	18	71	4.46	0.061
10	W12 HC	511	122	17	73	3.67	0.05
	TOTAL	5194	1246	178	742	55.06	0.738
	Mean± SD	519.4± 73.85	124.60± 17.67	17.80± 2.658	74.20± 10.549	5.51± 1.455	0.074± 0.016

Healthcare Waste Characterization

Healthcare waste generation by hazardous and non-hazardous waste Proportion: The total amount of healthcare waste generation rate per seven days in all of health centers was 385.4kg/week, with a mean(±SD), of 38.54±10.186kg/week. Out of this, 105.6kg/week (27.40%) was general and the rest 279.8kg/week(72.60%) was hazardous waste(Table 6).

Table 6: Healthcare waste generation by hazardous and non-hazardous waste Proportion in studied health centers of NSL sub-city, Ethiopia, 2020

S.no	Name of HC	Total HCW in 7 days (kg/week) Mean ± SD	Total general waste generated in each HC in a week(kg/week) Mean ± SD(%)	Total hazardous waste generated in each HC in a week(kg/week) Mean ± SD(%)	Daily waste generated in each HC (kg/day) (Mean±SD)
1	W1 HC	48.6	11.8(24.28%)	36.8(75.72%)	6.94±1.873
2	W2 HC	22.7	10.4(45.81%)	12.3(54.19%)	3.24±1.061
3	W3 HC	52.1	9.4(18.04%)	42.7(81.96%)	7.44±1.743
4	W4 HC	44.3	11.4(25.73%)	32.9(74.27%)	6.33±1.451
5	W5 HC	35.9	10.4(28.97%)	25.5(71.03%)	5.13±1.837
6	W6 HC	33.1	10.5(31.42%)	22.6(68.58%)	4.73±1.121
7	W9 HC	46.6	10.5(22.53%)	36.1(77.47%)	6.66±1.832
8	W10 HC	45.2	10.5(23.23%)	34.7(76.77%)	6.46±1.927
9	W11 HC	31.2	10.5(33.65%)	20.7(66.35%)	4.46±1.028
10	W12 HC	25.7	10.2(39.69%)	15.5(60.31%)	3.67±.725
	TOTAL	385.4	105.6(27.40%)	279.8(72.60%)	55.06
	Mean± SD	38.54± 10.186	10.56± .648	27.98± 10.108	5.51± 1.455

Healthcare waste generation rate by service delivery sections: As shown in Table 7, the highest amounts of HCWs were generated from OPD, which was 72.3kg/week, accounted for 18.76% of HCW, whereas, the least amount was recorded at TB follow up Unit, which was 22.5kg/week, accounted for 5.84% of HCW(Table 7).

Table 7: Healthcare waste generation rate by service delivery sectionsin studied health centers of NSL sub-city, Ethiopia, 2020

S.no	Departments /Units/	Total HCW in all HCs per week(kg/week), amount with %
1	OPD	72.3(18.76%)
2	Pharmacy	71.2(18. 48%)
3	Lab/VCT & ART	59.4(15.41%)
4	Injection & Dressing	40.4(10.48%)
5	MCH, FP & EPI	40.5(10.51%)
6	TB follow up Unit	22.5(5.84 %)
7	Delivery ward	34.0(8.82 %)
8	Emergency	45.1(11.70%)
	TOTAL	385.4

Distribution of types and amount of healthcare waste generation: The types of waste generated from studied health centers were sharps, infectious, pathological, pharmaceutical and general waste. The mean(±SD) generation rate of sharps [8.96±3.58kg/week (32.02%)], infectious[10.87±4.56kg/week(38.85%),pathological[2.29±0.80kg/week(8.18%)],pharmaceutical[5.86±2.10kg/week(20.94%)] and general waste[10.56±0.64kg/week (27.4%)] (Table 8).

Table 8: Distribution of types and amount of healthcare waste generation in health centers of NSL sub city, Ethiopia, 2020

S.no	Name of HC	General (kg/week) Mean±SD	Sharp (kg/week) Mean±SD	Infectious (kg/week) Mean±SD	Pathological (kg/week) Mean±SD	Pharmaceuticl (kg/week) Mean±SD	Total HW (kg/week) Mean±SD
1	W1 HC	11.8	12.1	15.2	2.7	6.8	36.8
2	W2 HC	10.4	3.4	5.3	1.4	2.2	12.3
3	W3 HC	9.4	14.3	16.6	2.1	9.7	42.7
4	W4 HC	11.4	10.1	13.5	3.1	6.2	32.9
5	W5 HC	10.4	8.3	9.8	2.1	5.3	25.5
6	W6 HC	10.5	7.8	8.1	1.1	5.6	22.6
7	W9 HC	10.5	11.2	14.5	2.3	8.1	36.1
8	W10 HC	10.5	12.0	14.9	2.8	5.0	34.7
9	W11 HC	10.5	5.7	5.3	3.7	6.0	20.7
10	W12 HC	10.2	4.7	5.5	1.6	3.7	15.5
	TOTAL	105.6 (27.40%)	89.6 (32.02%)	108.7 (38.85%)	22.9 (8.18%)	58.6 (20.94%)	279.8 (72.60%)
	Mean± SD	10.56± .648	8.96± 3.58	10.87± 4.56	2.29± 0.80	5.86± 2.10	27.98± 10.108

One-way ANOVA test was used to determine healthcare waste generation variation by number of patient flow. According to the result, healthcare waste generation rate varies by number of patient flow in most of the study days with ($p<0.001$).

Healthcare waste management practice

9 in 10 of the assessed health centers were practicing hazardous and non- hazardous waste segregation at point of generation during data collection time. However, more than half of health centers segregate HCWs inappropriate way.

9 in 10 of health centers used separate containers (safety boxes or covered plastic buckets) for the on-site HCW collection with inadequate collection equipments in each of delivery unit, of which 7 of health centers had a color-coding collection system and 2 were labeling practice for HCW. Whereas, only 1health center had neither color codes nor labeling practice for HCW. In addition to this, 10% of containers had warning signals on it and 4 in 10 of health centers, used clearly stated programs to collect wastes from different departments.

Out of ten health centers, only 2 of them had a separate place for storing wastes temporarily. It was observed inthe health center of woreda 1 and 5 which was temporarily stored wastes in a plastic bucket and bin respectively.

Only 3 in 10 of health centers were used plastic buckets and safety boxes to transport HCW manually hanging by cleaning personnel to the disposal site. Most of the devices used for on-site transportation of HCW were open or unprotected. Almost in all HCs, HCW wasn't transported to an off-site area.

None of health centers were treated HW before disposed and disinfected collection equipment for reuse.

All of health centers used single chamber local built bricks incineration, besides, 3 of them used open pit burning, and 9 of them used small Burial and placenta pit as a final disposal system. However, out of ten health centers, 7 of them had functional incinerators during data collection time. Whereas, less than half or 3 of health centers used local built bricks incineration with some limitation such as mixed waste (Figure 2).

Figure 2: Mixed disposal of HCW with open door constructed incinerator in studied health center of woreda10.

Discussion

According to the result, the mean HCW generation rate per patient flow per day in studied health centers were 0.074±.016kg/pat/day. This result was relatively higher than study done in HCs of Bench Maji Zone, 2018 and Adama, 2016, Ethiopia ranged from (0.0152-0.03kg/patient/day) (24, 25). This could be due to consistent increments of waste generation rate regarding to patient flow. In addition, it might be also due to the type of health service demand expressed by patients, which further determines the amount of waste generated. In general, waste generation rate per day per health center was higher in this study, even so, less number of patient flow was recorded due to covid 19 as compare to previous study which was done in Addis Ababa, Ethiopia, 2014 which has great contribution for the total waste generation rate.

The mean(±SD) daily healthcare waste generation rate in all studied health centers was 5.51±1.455kg/day, of which, 1.51±.092kg/day(27.4%) was general and the remaining 3.99±1.445(72.6%) was hazardous waste. High proportion of hazardous waste generation was observed in this study. This result was higher than a result obtained in HCs of Addis Ababa, Ethiopia, 2014, West Gojjam Zone, Amhara Region, Ethiopia, 2010, and Bench Maji Zone, Ethiopia, 2018, with a mean of 5.97±2.31kg/day(61.5%), 0.86±0.33kg/day(48%) and 1.144±0.34kg/day(42.1%) was hazardous waste respectively(24,26,27).

This high level of hazardous waste generation could be due to lack adequate information, less commitment and attention was given to appropriate wastes segregation practice with different waste catagories at a point of generation, which was observed during data collection period in most of health centers. Lack of appropriate HCW segregation practice according to WHO guideline and absence of any treatment, reusing or recycling activities shown in this study are also the main reasons for increased amount of hazardous waste sgeneration. In addition, the low economic status of patients who live in low income area and patients do not have lengthy stays in the health centers due to Covid-9 may lead to lower production of general waste, and there fore the proportion of hazardous waste was high in comparison. Similarly, the health service demand expressed by patients, which further determines the type of waste generated.

However, it was some how closer to a study done in HCs of Adama, Ethiopia, 2016 with a mean of 3.3±0.419kg/day(74.7%) was hazardous waste. These might be due to similarity in population characteristics on safe behavior towards waste management practice, availability of adequate waste collection equipments and options for proper waste segregation with

different waste catagories at point of generation, including waste treatment, disposal, reuse, and recycling practices, which contribute more to waste generation rate. In general, the majority of the review literatures including this study indicated that, out of the total HCW generated in all health centers, hazardous waste had an average high proportion of generation than non-hazardous waste, which was (64.55%) and (36.45%) respectively (24-27).

According to this study, 9 in 10 of studied health centers were practicing healthcare waste segregation at point of a generation with a number of limitation incuding, lack of awwareness, inadequate availability of waste collection equipments with color-coding, less commitment and attention was given to waste segregation among waste handlers and health proffessionals that was seen during data collection time which caused mixing of wastes. Even so, 9 in 10 of studied health centers were practicing healthcare waste segregation at point of a generation, more than half of health centers segregated HCWs inappropriately.

This result was higher than a study done in the health centers of Bench Maji Zone, Ethiopia 2018, and Adama, Ethiopia, 2016, which was 2 and 0 respectively(24,25). The discrepancy could be due to differences in study areas and target group characteristics such as, adequate knowledge & safe behaviour towords waste management includind waste segregation, availability of different facilities and resource allocation, better financial & logistics management, as well as the perceptions and socio cultural practice that has more contribution to proper waste segregation.

None of the health centers were treated HCW before disposed of. This result was, completely similar to a result obtained in HCs of Addis Ababa, Ethiopia 2014, West Gojjam Zone, Amhara Region, Ethiopia 2010, Bench Maji Zone, Ethiopia 2018 and in Adama, Ethiopia 2016 which was, none(24-27). This might occur due to similarity on awareness about potential health hazard, perception, advanced technology used related to HCW treatment and socio economic factors which has contribution to healthcare waste treatment.

10 of health centers used local built bricks incinerators as a final disposal system with the number of limitations like, disposed different types of wastes tighter improperly, that was seen during data collection time. This result was similar to a study done in health centers of Addis Ababa, Ethiopia, 2014, which was 10 health centers(27). This could be due to similarity instudy areas and target group characteristics, Such as, knowledge and safe behaviour regarding to waste disposalt which has more contribution to proper waste disposal.

However, it was higher than, a study done in health centers of West Gojjam Zone, Amhara Region, 2010, Bench Maji Zone, 2018, and Adama, Ethiopia, 2016, which was about 5 health centers(24-26). This might be due to a variation on socio-culture & socio-economics factors, knowledge, and technology used.

Strengths and Limitations of the study

Strengths of the study

- All health centers found in the sub-city were included in this study.
- Cheking the weighing scale calibration before starting the data collection.

Limitations of the study

- The study was conducted only in one sub-city of the city administration due to financial constraint.
- This study mainly focused on health centers which have not been included other health institution such as hospitals and private ones.
- The observation was conducted at one point in time which did not account temporal variations.

Conclusion

The mean daily waste generation rate per patient flow per health center was relatively higher than similar study setting of on-line publication.

There was lack of appropriate healthcare waste segregation with different wastes catagories at point of generation and inadequate waste collection equipments in most of health centers.

Recommendations

To health centers: All HCs administration should be emphasized on waste segregation practice at the point of generation with different waste catagories within adequate color-coded collection containers.

To health centers: There should be a separated final waste disposal system for both hazardous and non-hazardous waste.

To health centers: There should be continual training programs for all concerned health personnel to raise their awareness and change behaviour towards proper HCW handling.

To health centers: All health Centers should have standard operational procedures for proper HCW handling practice that should be following WHO standards.

To the Ministry of Health: There should be enforcement of standard practices of health centers waste management in reference to the national guidelines and/or international guidelines.

To researchers: Further studies should be conducted by the researchers to assess seasonal waste generation variation.

To researchers: Further studies should be conducted at a large scale by including health centers from all sub-city of the city administration.

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Annexes

Addis Ababa University Health Science College, School of Public Health

Observational checklist designed to assess healthcare waste generation, characterization and management practice in health centers of NSL Sub-City Addis Ababa city, Ethiopia

Data collection date: _____ Health center name_____Health facility code_____

Annex I: Observational checklist for assessing HCWMS (English Version)

1) For waste segregation and collection

S. No	**Questions**	Response code	
		1.Yes	0.No
1	Is there waste segregation at the generation point in the health Unit?		
2	Are there black bins containers for non-hazardous health care waste segregation?		
3	Are there yellow bins containers for hazardous health care waste segregation?		
4	Does the health center use another waste segregation option? If yes, specify:_____		
5	Are the wastes containers appropriately sealed?		
6	Does hazardous and non-hazardous health care waste collect on a separate trolley?		
7	Does the health center havea clearly stated program to collect health care waste from different departments?		
8	Is there a warning signal/ signs/ on containers & places of the collection of health care waste?		

2) For waste transportation and on-site health care waste storage

S. No	Questions	1.Yes	0.No
1	Does the health center have a separate place for storing wastes temporarily?		
2	Is there a temporary waste storage bin having cover?		
3	Is there a temporary waste storage bin easily cleanable?		
4	Does the health center use plastic buckets and safety boxes to transport HCW to the disposal site?		
	Manually		
	Open or unprotected		

3) For waste treatment and disposal:

S. No	Questions	1.Yes	0.No
1	Does the health center treat health care waste before disposed of?		
	collection equipment		
2	Does the health centersuseas a final disposal system?		
	Single chamber local built bricks incineration		
	Had functional incinerators		
	Without proper protection to the surrounding, worn-out chimneys or no chimney, lack covers for waste feeding ashes & removing doors.		
	Open-pit burning,		
	Small burial and placenta pit		

Otherobservation:_____

Summary findings of observation:----------

Amharic Version Observational Checklist

/በአማርኛ የተተረጎመ ቼክሊስት/

አዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል

የአዲስ አበባ ከተማ አስተዳደር የንፋስ ስልክ ላፍቶ ክፍለ ከተማ ጤና ጣቢያዎች ላይ የመርዛማ ቆሻሻ መመንጨት ዋንኛ ምክንያቶች፣አይነትና የቆሻሻ አስተዳደር ችግሮችና መንስኤዎቻቸው ዙርያ ላይ የሚደረግ ዳሰሰ.

ዳሰሰ የተደረገበት ቀን_____የጤናተቃም ስም----------የጤ ናተቋም ኮድ---

Annex II: Amharic Version Observational checklist

/የቆሻሻአስተዳደርን የተመለከተ ቼክሊስት/

1) **የቆሻሻ አሰባሰብና በአይነት መለየትን በተመለከተ**

ተ.ቁ	**ጥያቄ**	**ምላሽኮድ**	
		1.አዎ	0.አይደለም
1	በተቋሙ ውስጥ ቆሻሻ ከምንጩ ይለያ ልወይ ?		
2	መደበኛ የሆነቆሻሻ በጥቁር እቃ ተለይቶ ይሰበሰባል ወይ ?		
3	መርዛማ የሆነቆሻሻበቢጫ እቃ ተለይቶ ይሰበሰባል ወይ ?		
4	ተቋሙ ሌላቆሻሻ የመለያ አማራጭ አለው ? አዎ ከሆነይገለጽ:_____		
5	የቆሻሻ መያዣ ዕቃ በአግባቡ የተከደነነው ወይ?		
6	መርዛማና መርዛማ ያልሆኑ የጤና ተቋማት ቆሻሻ በሚገፉ ጋሪ ተለይተው ይሰበሰባሉ ወይ?		
7	በተቋሙ ውስጥ በግልጽ የተቀመጠ ከየክፍሉ ቆሻሻን የማሰባሰቢያ ፕሮግራም አለወይ?		
8	በቆሻሻ ማጠራቀሚያ እቃ ላይና ቆሻሻ ማጠራቀሚያ ቦታ አከባቢ ላይ አደገኛ የሚል ምልክት አለ ወይ?		

2)የቆሻሻ ማጠራቀሚያና ማጋጋጥን በተመለከተ

ተ.ቁ	ጥያቄ	1.አዎ	0.አይደለም
1	ጤና ጣቢያው የተለየ ጊዜያዊ የቆሻሻ ማጠራቀሚያ ቦታ አለው ወይ ?		
2	መክደኛ ያለው ጊዜያዊ የቆሻሻ ማጠራቀሚያ እቃ አለ ወይ ?		
3	በቀላሉ ሊጸዳየሚችል የቆሻሻ ማጠራቀሚያ ነው ወይ ?		
4	ጤና ጣቢያው ቆሻሻንወደ መስወገጃ ቦታ ማጋጋጥ እቃ አለወይ ?		
	በእጅ የሚገፋ		
	ክፍትናመከላከያየሌለው		

3) ቆሻሻን የማከምና የማስወገድ አገልግሎትን በተመለከተ

ተ.ቁ	ጥያቄ	1.አዎ	0.አይደለም
1	ጤናጣቢያው ቆሻሻ ከማስወገዱ በፊት ያክመል ወይ?		
	የቆሻሻ ማሰባሰቢያ እቃችን ያክመል ወይ?		
2	ጤና ጣቢያው የመጨረሻ የቆሻሻ መስወገጃ ስልት አለው ወይ ?		
	ከአከባቢው ቁስ / ብሎኬት የተሰራ/ ኢንሲኔራተር		
	በአግባቡ የሚሰራ		
	በአግባቡ የማይሰራ፣ያልተከለለ፣ጨስ ማውጫእና በር የሌለው /ያረጀ/፣		
	ክፍት ቆሻሻ ማቃጠያ ጉድጋድ		
	መቅበሪያ/ፕላሴንታ ጉድጋድ		

ተጨማሪምልከታዎች_____

_____

ማጣቃለያ ምልከታዎች_____

Annex III: Seven consecutive day healthcare waste generation sheet by HC & Departments (kg/day)

Health Center Name---------- Code---------

Departments /Units/	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
OPD								
Pharmacy								
Laboratory								
Injection & Dressing								
MCH, FP &EPI								
VCT & ART								
TB follow up Unit								
Delivery ward								
Emergency								
TOTAL								

Annex IV:Total healthcare waste generation registration sheet by HC & Departments (kg/day)

HC	OPD	Pharmacy	Laboratory	Injection & Dressing	MCH, FP &EPI	VCT & ART	TB follow up Unit	Delivery ward	Emergency	Total HW
Total										

Annex V: Seven consecutive day healthcare waste generation sheet by HC & HCW type (kg/day)

Health Center Name---------- Code---------

Waste category	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
General								
Sharp								
Infectious								
Pathological								
Pharmaceutical								
Total hazardous								
Total								

Annex VI:Total healthcare waste generation registration sheetby HC & HCW type (kg/day)

Health center name	General waste	Sharp	Infectious	Pathological	Pharmaceutical	Total hazardous
TOTAL						

Annex VII: Seven consecutive day patient flow sheet by HC & Departments /Units/

Health Center Name---------- Code---------

Departments /Units/	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
OPD								
Pharmacy								
Laboratory								
Injection & Dressing								
MCH, FP &EPI								
VCT & ART								
TB follow up Unit								
Delivery ward								
Emergency								
TOTAL								

Annex VIII: Total patient flow sheet by HC & Departments /Units/

Name of HC	OPD	Pharmacy	Laboratory	Injection & Dressing	MCH, FP &EPI	VCT & ART	TB follow up Unit	Delivery ward	Emergency	Total
Total										

Annex IX: Total number of beds by HC & Departments /Units/

Name of HC	OPD	Pharmacy	Laboratory	Injection & Dressing	MCH, FP &EPI	VCT & ART	TB follow up Unit	Delivery ward	Emergency	Total
Total										

Annex X: Information sheet

My name is _____ I am working as a data collector for the study conducted in this health center by Biruk Birhane who is studying for his Master's degree at Addis Ababa University, College of Health Science, and School of Public Health. I kindly request you to give me your attention to explain to you about the study and study participant.

The study title: Assessments of health care waste generation rate, its characterization, and management practice in health centers of Nifasilk Lafto Sub-city, Addis Ababa, 2020.

Purpose of the study: The main aim of this study is to write a thesis as partial fulfillment of a Master's degree in public health for the principal investigator. After completion of this study, the results were used as evidence and enhanced safe waste handling practice.

Procedure and duration: I will be assessing the healthcare waste generation rate, its characterization and management practice by using Checklist, and weighting measurement scale and this may take not more than 30 to 45 minutes, and the procedures will take place in your working environment.

Risks and benefits: The risk of participating in this study is nil. There would have no direct benefits for being a study participant but indirectly the findings from this research will be important by identifying the main determinant factors of waste generation and giving solutions for a safe healthcare waste management system also, it is important as bases of future study.

Confidentiality: All information forwarded kept confidential and names will not be written.

Rights: Permitting this study is voluntary. You have the right to permit or not for this study. If you decide to permit the study, you have the right to terminate the study at any time if you consider something related to the study is wrong.

Contact address: If you have any questions, which is not clear to you can contact Addis Ababa University, College of Health Science, School of Public Health or you can get the address of the investigator.

Investigator: BirukBirhane.

Tell +251-910 805804

Email birukbirhane122116@gmail.com

Annex XI: የስምምት ማሳወቂያቅጽ

ስሜ.....ይባላል፡፡እዚህ የተገኘሁት የአዲስ አበባ ዩኒቨርስቲ ጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና ሳይንስ የድህረ-ምረቃ ተማሪ የሆኑት አቶ ብሩክ ብርሃን ወክየው ነው፡፡እሳቸውም የአዲስ አበባ ከተማ አስተዳደር የንፋስ ስልክ ላፍቶ ክፍለ ከተማ ጤና ጣቢያዎች ላይ የመርዛማ ቆሻሻ የመመንጨት መጠንና ዋንኛ ምክንያቶችን፣የመርዛማ ቆሻሻ አስተዳደር ችግሮችና መፍትሄዎቻቸው ዙርያ ላይ ጥናት በመስራት ላይ ይገኛሉ፡፡ ይህንን ጥናት ለማካሄድ ተሳታፊ የሚሆኑትን በሎቶሪ የናሙና አወጣጥ ምልመላ ሲካሄድ እርሶ በዚህ ጥናት እንዲሳተፉ የተመረጡ ሲሆን ዳሳሳ ለማድረግ 1.ለጥናቱ የተዘጋጀ መጠይቅ እጠቀማለው 2. ቀላል ዘዴ በመጠቀም የመርዛማ ቆሻሻ መመንጨት መጠንን እለካለሁ ይህም የእርሶን ሙሉ ትብብርየ ሚጠይቅ ይሆናል፡፡ስለሂደቱም አጭር ገለጻ ይደረጋል፡፡ልኬቱና ተያያዥ ስራዎች የሚካሄደት ሥራ ቦታ ሲሆን የሚወስደው ጊዜከ 30-45 ደቂቃ ያልበለጠ ነው፡፡የምትሰጡን መረጃ ሁሉም ሚስጢራዊቱ የተጠበቀና ቅፅ ላይ ስም አይሰፍርም፡፡ከጥናቱ በቀጥታ የሚገኙት ጥቅም የለም፡፡ነገር ግን በተዘዋዋሪም ጥናቱ የአዲስ አበባ ከተማ አስተዳደር የንፋስ ስልክ ላፍቶ ክፍለ ከተማ ጤና ጣቢያዎች ላይ የመርዛማ ቆሻሻ መመንጨት መጠን ዋንኛ ምክንያቶችን በመለየት፣የአስተዳደር ችግሮች ናመፍትሄዎቻቸው ዙርያ ላይ ትልቅ የሆነየመፍቴ አስተዋፅኦ ይኖረዋል፡፡በተጨማሪም ለቀጣይ ምርምር መሰረት በመሆን ያገለግላል፡፡

ስለዚህ በጥናቱ መሳተፍም ሆነ አለመሳተፍ የእርሶ መብት ነው፡፡ከጥናት ጋር ተያያዥ ጥያቄ ካለዎት ወይም ተጨማሪ መረጃ ከፈለጉ ከአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና ሳይንስ ትምህርት ክፍልን ወይም ጥናት አድራጊውን በሚከተለው አድራሻ ማግኘት ይችላሉ፡፡

ጥናትአድራጊው፡- ብሩክብርሃነ

ስልክ+251-910805804

ኢሜል birukbirhane122116@gmail.com

Annex XII: Informed consent

Detailed information about the study explained to me. I have understood that the objective of this study is to assess the health care waste generation rate, factors determine, and waste management practice problems and its solutions. Also, I understood how the data collection is proceeding and the time it takes to complete the data collection. I also understood that the research imposes no risk on me. I assured that my response would be confidential and collected data used only for the study. It also explained to me that I have the right to stop participation at any time. Besides, I understood that participating in this study is important for scientific knowledge and base for further study. Therefore, I have now consented to participate in the study by signing this form.

Signature of participants_____ date _____

Name and signature of data collector_____ date _____

Annex XIII: Amharic Version Informed consent / የስምምነት መዋዋያ ቅጽ/

ጥናቱን በሚያካሂደው አካል ስለ ጥናት በቂ መረጃ ተሰጥቶኛል፡፡የዚህ ጥናት ዓላማም የመርዛማ ቆሻሻ መመንጨት መጠን ሁኔታና የዚህ ዋንኛ ምክንያቶችን፣የመርዛማ ቆሻሻ አስተዳደር ችግሮችና መፍትሄዎቻቸው ዙርያ ላይ ጥናት ለማድረግ መሆኑን ተረድቻለሁ፡፡ ከኔ የሚወሰደው መረጃ በእኔ ላይ ምንም ዓይነት ጉዳት የማያስከትልና መረጃውን ለጥናት ዓላማ ብቻ እንደሚውል ተረድቻለሁ፡፡ማንኛውም እኔን የተመለከተ መረጃ ሚስጥራዊነቱ የተጠበቀ ነው፡፡እንደዚሁም በጥናቱ ለመሳተፍ ፍቃደኛ ካልሆንኩ በጥናቱም ለመሳተፍ እንደማልገደድ ነገር ግን በዚህ ጥናት መሳተፌ ለሳይንሳዊ ዕውቀት ጠቃሚ መረጃ የማበርከትና ወደፊት በዚህ ዙሪያ ለሚሰሩ ስራዎች መሰረት የሚሆኑ ግብዓት መስጠት እንደምችል ተረድቻለሁ፡፡በመሆኑም በዚህ ጥናት ላይ ለመሳተፍ የተስማማሁ መሆኔን በፊርማዬ አረጋግጣለሁ፡፡

የጥናት የተሳታፊው ፊርማ…….…….. ቀን……..
መረጃ ሰብሳቢ ስምና ፊርማ…… ቀን……..

Annex XIV: Field Training Manual

Prepared by: BirukBirhane

Prepared for: Data collectors and supervisor

Date: June 12/2020

Title of training: How to fill different cheek lists and how to ask questions properly and technical practice on measuring healthcare waste generation rate.

Outline of training manual presentation

- Introduction
- Objectives of training
- Training methods and Materials
- Training Content/elements
- Trainersmonitoring and evaluation
- References

Introduction

This introductory session provides guidance on preparation for the training, including logistics, lesson planning, and Training schedule. It will also help to appreciate the principles of adult learning and some of the facilitation skills will be required to have to carry out effective training. When using a lesson that has already been prepared, ensure that you are thoroughly familiar with the material, including evaluation tools to assess training progress; selected training methods, materials, and techniques; and the schedule or timetable. As you prepare, it is important to remember that the following activities will be required of you during and after the training exercise:

Objectives of training [Overview]

- To understand how to fill the cheek lists and questionnaires properly and to reduce errors.
- To discuss and explain what does it mean each point in cheek list and questioners
- To practice how to measure HCW generation rate using measuring scale and
- To know how to communicate with the head of health centers and different departments.

Methodology

Training methods

- Lecture on contents in more detail and Group discussion withinasmall number of trainers due to covid19.
- Further discussion with Phone communication and with other online technology like telegram from data collectors and supervisors.
- Brainstorming- quicklygenerate ideas and can get all participants to involve in collecting a lot of information.

Participants: 10 Data collectors and 2 supervisors from Addis Ababa FMHACA office environmental health professionals [BSc] and each health center.

Training location- it will be held on in the Nifasilk Lafto Sub-city FMHACA office.

Training Materials

- **Training manuals-** from Google search of training manuals, different written documents, and from a thesis research proposal.

The trainer should ensure that the following materials are available as required:

- PowerPoint files.
- Printing paper.
- Writing paper.
- Computer/laptop/projector

Personal protective equipment (PPE):-This is used for data collectors during data collection especially while measuring healthcare waste.

- Gloves
- Mouth masks.

Qualification of trainers: Master candidate in public health.

Training program and budget

- Day: June 12/2020.
- Duration 3 hour
- Duration of Program: 0ne[1] day training and
- Budget: 1,800.00 ETB

Training Content/elements

1. Data collection and sources of data

- Scope: the scope comprises HCWG, segregated, collected, transported, treated, and disposedofin the HCrs of different departments.
- Sources and institutions: HCWMPdata in the HCs of NSLSub-City.
- Waste composition is collected periodically and the waste generation rate willbe measured by using a measuring scale by data collectors.
- Statistical unit: Any relevant information obtained from the interview and observation will put soon on the data collection forms and compiled.
- Measurement units: The weight obtained from measuring healthcare wastes will be recorded in kg/day as soon as in the field every working day.

2. Fill with data collection formsand completing the data collection forms

All personnel involved in data collection and supervision require training to ensure reliable and accurate data collection, completion of the data collection form, and transfer of data to the compilation forms. Training should also important for generating high-quality data. The training ensures a common understanding of the data collection form used in the fieldwork and will save much time and effort during the data checking.

Upon completion of the training, participants should: be familiar with the key aspects of the survey and how it is conducted; understand their roles and responsibilities in the survey, including specific tasks, timelines, and reporting requirements; understand the critical content required to do their job effectively and possess the skills required to undertake each of their activities; be aware of common issues that may arise during survey activities, and problem-solving strategies to address these issues; and recognize the intrinsic value of good-quality data and be motivated to ensure data quality as part of their activities.

Training should therefore focus on teaching the participants: the survey's overall purpose; how to fill and complete the Data Collection form; the consequences of poor-quality data and problem-solving systems in the field.

3. Data quality and checking: The purpose or aim of this training is to have data with quality standards. Data quality will be measured by using different techniques. For example, before data collection, one-day training will be given to the data collectors and supervisors to fill the questionnaire properly and to reduce errors. Based on the training effectivityre-training of the data collectors will be done quickly.

Finally, the performance of data collectors on their daily activities will be checked and assured by supervisors at the end of the day.

4. Practical exercise on how to measure the healthcare waste generation rate by using measuring weight or scale.

4.1 Practical exercise on how to measure healthcare waste generation rate

It is recommended that a practical exercise that covers data collection and data entry last at least two day. It should include a data collection pilot test in which survey personnel visit the public health center and collect data in the same way they would during actual field work. This will not only provide survey personnel with practical experience in collecting data but will also serve as a check of the appropriateness fill of the data collection forms.

The participants should include all supervisors and data collectors. Plan data collection pilot test; during the data collection pilot test, boththedata collection team (supervisors and his or her data collectors) will visit one public health center and collect data by following the survey procedures. Thus, one health center is required for both the data collection team to serve as pilot sites.Before the training exercise, a written schedule should be prepared for each data collection team, indicating the time and location of each health center visit, including the name and contact details of the person in charge at the facility.

The schedule should also contain the supervisor's telephone number so that surveyed personnel can call if there is a problem.Secure equipment needed ideally, one healthcare waste measurement scale per data collection team, and access to photocopy for reproducing data collection forms. Prepare documentation materials one copy of the Data Collection form, exercises, and measuring scale for each participant for use during the pilot test.

4.2 Weighing Health Care Waste Generation Rate

Health care waste should be quantified by weight, labeled with information on its source, and recorded. Waste should be weighed at the generation point to quantify waste being generated on specified departments or delivery units. If waste is to be transported offsite for treatment, it should be weighed at the facility first, before being transported. Full safety boxes should also be recorded.

Monitoring and Evaluation

Monitoring: continuous measurement of progress while the activity is ongoing.

Objectives of monitoring include:

- Checking and measuring progress.
- Analyzing the situation.
- Clearly state the indicators to be monitored [Collected data].
- Collect data through supervision [Analyze performance].
- Document the data collected and provide feedback.

Evaluation: The measurement of progress and impact when any activity is completed.

Forms of evaluation:-

- **Trainer Selection- the** selection of data collectors and supervisors is based on their previous experiences.
- **Participant check during training -** Data collectors'efficiencywill be checked & assured by the trainers during the training time by performing technical practice.
- **Post-training participant feedback-** Support the data collectors by the supervisors during their daily activities and based on the finding re-training of the data collectors will be done quickly.

Steps to ensure successful supervision:-

1. Set up a support system. This involves:

a. Guidingof data collectors.

b. Creating a checklist, supervision tools, or job aids to update data collectorsduring supervision.

c. Ensuring the availability of resources.

2. Planning regular supervisory visits:

a. Use data to determine areas to supervise.

b. Schedule supervision routinely using the work plan.

c. Identify support areas and skills that require updating.

d. Follow up on recommendations made during the previous visit.

e. Plan to spend as much time as required (this will depend on the needs).

3. Conduct supportive supervision, which includes:

a. Observation. b. Using data.

c. Solving problems. d. Recording observations and feedback.

4) Follow-up:

a. Follow up on agreed actions by supervisors and supervised data collectors.

b. Perform regular data analysis.

c. Provide feedback to all data collectors.

5) Building sustainability:

a. Ensure sustainability of supportive supervision within the system.

b. Advocate for supportive supervision.

c. Developateam approach to increase supportive supervision and make it routine.

Reference–Google search for field training manuals on data collectors and supervisors.

Annex XV:Training of data collectors and supervisors, in Nifasilk Lafto sub-city, FMHACA Office, June, 15/2020.

Annex XVI: Healthcare Waste Measuring photos

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH
DEPARTMENT OF PREVENTIVE MEDICINE

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ጉዳዩ፡ ትብብር ስለመጠየቅ

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Addis Ababa University
Department of Preventive Medicine
School Public Health
College of Health Sciences

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☎ 251-11-5157701
Fax: 251-11-5517701
Email: publichealth@aau.edu.et

☎ 251-11-5157701
ፋክስ: 251-11-5517701
ኢ-ሜል: publichealth@aau.edu.et

አዲስ አበባ ከተማ አስተዳደር ጤና ቢሮ
City Government of Addis Ababa Health Bureau

Ref.No. አ/ል/ዘ/10288/227
Date 17/10/12

TO:

- **NIFASILK LAFTO SUB CITY HEALTH OFFICE**
  Addis Ababa.

Subject: Request to access Facilities to conduct approved research

The letter is to support **BIRUK BIRHANE "ASSESSEMENT OF HEALTH CARE WASTE GENERATION, DETERMINANT FACTORS AND MANAGEMENT PRACTICE IN HEALTH CENTERS OF NIFASILK LAFTO SUB CITY, ADDIS ABABA, ETHIOPIA."** The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study procedures and submit an activity progress report to the Ethical Committee as required. Therefore we request the facility and staffs to provide support to the principal investigator.

With Regards

Ethical Clearance Committee

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Cc

- **BIRUK BIRHANE**
- **To Ethical Clearance Committee**

Declaration

I, the undersigned, declared that this my original work has never been presented for degree in this or other university and that all sources of materials used for this thesis has been fully acknowledged.

Name: Biruk Birhane

Signature _____

Place: Addis Ababa University

Date of submission_____

This thesis has been submitted for examination with my approval as university advisor.

Approval of the Primary Advisor

Name of the Primary Advisor: _____

Date: _____ Signature_____

Approval by the board of examination

This is to certify that the thesis prepared by Biruk Birhane, entitled: Assessment of Health Care Waste Generation, Its Characterization and Management Practice in Health Centers of Nifas Silk Lafto Sub-City, Addis Ababa, Ethiopia. and submitted in fulfillment of the requirements for the Degree of Masters of Public Health in General Public Health complies with the regulations of the University and meets the accepted standards with respect to originality and quality.
Signed by:

External Examiner	sign	Date
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Internal Examiner	sign	Date
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Advisor	sign	Date
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