ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCE
SCHOOL OF ALLIED HEALTH SCIENCE
DEPARTMENT OF MEDICAL LABORATORY SCIENCES

Assessment of Knowledge, Attitude, and Practice about Bio-Medical Waste Management and Associated Factors among Health Care Workers at Debre Markos Town Health Care Facilities, Northwest Ethiopia

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This is to certify that the thesis prepared by Teshiwal Deress, entitled: ***Assessment of Knowledge, Attitude, and Practice about Bio-Medical Waste Management and Associated Factors among Health Care Workers at Debre Markos Town Health Care Facilities, Northwest Ethiopia*** and submitted in fulfilment of the requirements for the Degree in Master of Science in Clinical Laboratory Sciences (Clinical Laboratory Management and Quality Assurance specialty track) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Table of contents

List of tables

List of figures

List of abbreviations and acronyms

AIDS	……..	Acquired Immune Deficiency Syndrome
BMW	……..	Biomedical Waste
BMWM	……..	Biomedical Waste Management
BSc	……..	Bachelor of Sciences
DRERC	……..	Departmental Research and Ethics Review Committee
FEPA	……..	Federal Environmental Protection Authority
FMOH	……..	Federal Ministry of Health
HBV	……..	Hepatitis B virus
HCFs	……..	Health Care Facilities
HCPs	……..	Health Care Professionals
HCV	……..	Hepatitis C virus
HCWs	……..	Health Care Workers
HIV	…….	Human Immunodeficiency Virus
HO	……..	Health Officer
KAP	……..	Knowledge Attitude and Practice
MSc	……..	Masters of Sciences
SPSS	……..	Statistical Package for Social Sciences
WHO	……..	World Health Organization

Operational definitions and terms

Knowledge: Aability of study participants to respond biomedical waste management questions designed to assess knowledge and it is measured in terms of knowledge scores. Knowledge scores below mean and above or equal to mean score (16.25) were categorized as having 'Inadequate' and 'Adequate' knowledge, respectively.

Attitude: Study participants' personal optimistic opinion, outlook or idea towards BMWM. Attitude scores below mean and equal to or above mean score (66.38) were considered as 'Negative' and 'Positive' attitude, respectively. Favourable and unfavourable attitudes in other studies were equivalently discussed with positive and negative attitudes, respectively.

Practice: It is a way of doing something in an expected way in a particular situation. Likewise, knowledge and attitude scores, practices of study participants were bifurcated into two categories. Practice scores below mean and above or equal to mean score were categorized as 'Inadequate' and 'Adequate' practice, respectively.

Availability of sufficient glove: means presence of enough glove in the department/ health care delivery section for a daily working period.

Always, sometimes and never: Degree of frequencies were used to rate study participants' frequencies of using specific device or performing a specific activity. Always means a study participant have used a specific device or performed a specific activity constantly while it is necessary. Sometimes means a study participant have used a specific device or performed a specific activity occasionally whereas never means a study participant have used a specific device or performed a specific activity not at all times.

Other department: Means health care delivery rooms/ sections other than ward, OPD, laboratory and emergency rooms

Other information source: Means BMWM information sources other than guideline, training and frained

Health care workers: Health care workers are people who are involved in the promotion, protection and enhancement of population heath. In this study, a term health care worker is stand for those clinical staff (health care professionals) and non-clinical staff (cleaners).

Availability of sufficient PPE: means presence of each equipment at least per individual assuming that are reusable

Bio-medical waste: waste which is generated during diagnosis, treatment or immunization of human beings or animals or research activities

Biomedical waste management: A process that helps to ensure proper health care facility hygiene and safety of health care workers and the community.

Waste segregation: Systematic separation of wastes generated from the HCFs according to their type (non-infectious, infectious and sharps) using color-coded containers for specific treatment and disposal requirements.

Color-coding: A system for relating the contents of waste containers by using different colours.

Biohazard symbol: A symbol that is universally recognized as a warning against substances that pose a threat to human health.

Waste storage: A temporary placement of waste in a suitable location where isolation, environmental, health protection, and human control are provided in order to ensure that waste is subsequently retrieved for treatment/ disposal.

Waste disposal: Waste disposal is the final placement of treated wastes using environmentally acceptable methods of final storage (burial, deposit, discharge, dumping, placing or release of any waste into or onto the environment) appropriate to national requirements.

Abstract

Background: Healthcare activities restore health and save lives; however, they inevitably generate wastes and by products which may be hazardous to human beings or environment. Generation and disposal of biomedical wastes has become an emerging problem worldwide. Knowledge, attitude and practice of health care workers affect outcomes of biomedical waste management and yet they are less investigated.

Objectives: To assess knowledge, attitude and practice about bio-medical waste management and associated factors among health care workers at Debre Markos town health care facilities, Northwest Ethiopia.

Methods: A cross-sectional study was employed from November 20, 2016 to June 12, 2017 among health care workers at Debre Markos town health care facilities. Data were collected through structured self-administered, interviewer administered questionnaires and observational checklists. Data were coded and entered into Epi-data 3.1 software and then exported into SPSS version 20 for analysis. Descriptive statistics was computed through cross tabulation. Bivariate and multivariable logistic regression analysis were computed to identify predictor variables significantly associated with the outcome variables. All variables with p value ≤ 0.2 in bivariate analysis were entered into multi-variable logistic regression model to adjust possible confounders. Variables with p value of <0.05 in the final analysis were considered to explain presence of association. Chronbach's Alpha internal consistency reliability test was used.

Result: A total of 351 health care workers were studied among 14 health care facilities. Adequate knowledge, positive attitude and adequate practice scores of health care workers' were found to be 193(55%), 218(62.1%) and 277(78.9%) respectively. Regarding associated factors, having >10-year work experience was 4.28 times more likely contribute for adequate knowledge score than study participants with 1-5 years work experience. Working 8 and more than 8 hours per day were 7 and 6.6 times, respectively, more likely to contribute for positive attitude than working less than 8 hours per day. Similarly, presence of all three color coded bins in the department/ health care delivery sections were 4.55 times more lkkely contribute for health care professionals' adequate practice score. Similarly, working hours per day (p= 0.014) and attitude scores (p=0.034) significantly associated with cleaners' practice score.

Conclusion and Recommendation: In this study knowledge, attitude and practice scores were low. Regular training and supervision with special emphasis for cleaners is necessary. There is should be supply of sufficient personal protective equipment.

Key words: Biomedical waste, waste management, knowledge, attitude, practice, health care worker.

1. Introduction

1.1 Background

Health care facilities while engaging in life saving activities, they generate wastes and by products that may be hazardous to human beings or environment which need to be handled safely and disposed properly in an environmental friendly manner [1].

According to world health organization (WHO), wastes produced by the health-care providers are broadly categorized as general (non-hazardous) and hazardous waste. General waste constitutes about 85% of the total waste produced in the health care facilities (HCFs) and it is comparable to domestic waste. This type of waste does not pose any risk to human being. The remaining 15% is however considered as hazardous which may pose a variety of environmental and health risks. Among this, about 10% is considered as infectious (biologically hazardous) while the remaining 5% regarded as hazardous but not infectious [2].

There are currently several terms used to describe waste generated from health care establishments such as clinical waste, health care waste, infectious waste and medical or biomedical waste are typically encountered [3].

Biomedical waste (BMW) is the waste which is generated during diagnosis, treatment or immunization of human beings or animals that may be contaminated with patients' body fluid which includes syringes, needles, ampoules, dressings, disposable plastics and microbiological wastes [4]. The main sources of BMWs are hospitals, clinics, other research facilities [5]. BMWs should be considered as a reservoir of pathogenic microorganisms, which can cause contamination and infection [6].

Proper biomedical waste management (BMWM) include vital steps (segregation, collection, storage, transportation, treatment, and final disposal) of wastes generated in the healthcare establishments [7, 8]; stages which require special attention are stipulated in Figure 1 [2, 9, 10, 11].

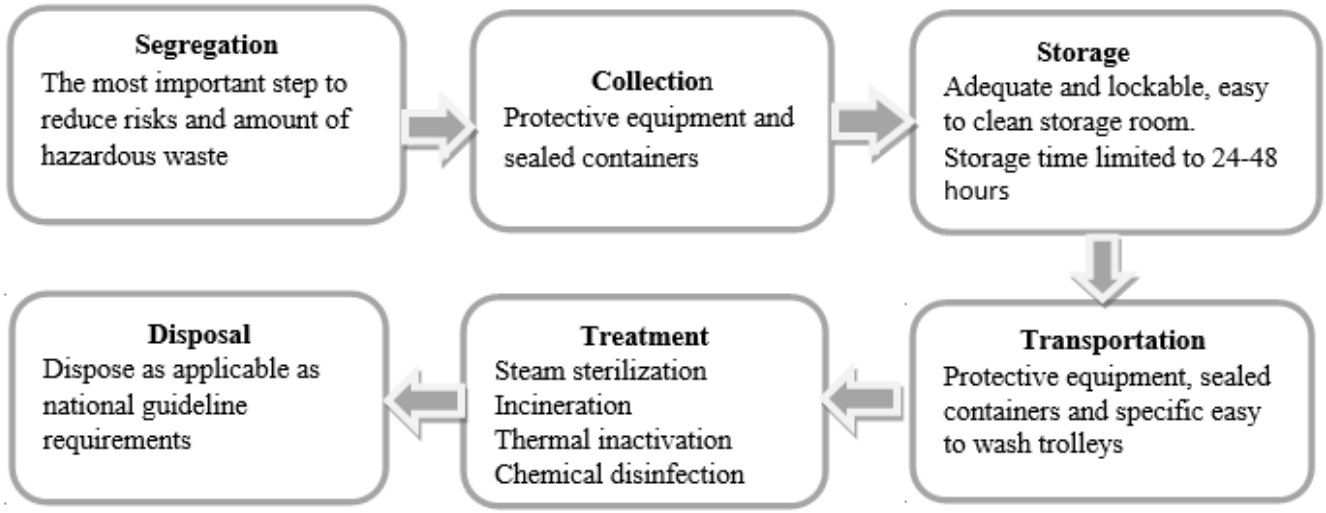


Figure 1. Biomedical waste management stream summarized from national and international guidelines [2, 10, 11]

Adequate knowledge, attitude and practice (KAP) of health care workers (HCWs) are key factors for having successful BMWM system as they are important preconditions to safe guard the community and environment from being contaminated with infectious substances. Deficient in either of these competencies may lead to indiscriminate BMW disposal and result serious public health and environmental problems.

1.2 Statement of the problem

Generation and disposal of BMWs has become an emerging problem worldwide [9] and its management is still at infancy and got attention recently [12] due to increased awareness about human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV) and other potential infectious diseases [13].

A systematic review of 150 articles published since 2000 revealed that at least 50% of the world population is threatened by environmental, occupational and public health risks due to poor management of health care wastes [14]. According to WHO, 10-25% of BMWs produced by health-care providers is hazardous [2]. However; proportions varied from country to country ranging between 20% and 75% [15-22], including reports from Ethiopia. Generation rate of hazardous BMW in Ethiopia is unacceptably higher compared with some other countries and threshold set by WHO [17-22]. BMWs could transmit more than 30 dangerous blood borne pathogens [23], with particular concern for HIV, HBV and HCV infections, for which there is strong evidence of their transmission through needle stick/sharp injury due to poor waste management. It is estimated that more than 2 million HCWs are exposed to percutaneous injuries with infected sharps every year [2].

All individuals, especially healthcare staffs who are exposed to BMWs are potentially at risk [24]. However, the highest rate of occupational injury among HCWs exposed to BMWs are reported mainly in the cleaning personnel and the existence of bacteria resistant to antibiotics and chemical disinfectants may contribute to the hazards created by poorly managed BMWs [2]. Cleaners are usually poorly educated, untrained and little attention is paid to their comfort and safety. It is uncommon for them to have vaccination or proper protective equipment [25].

Poor BMWM is a problem in most developing countries and many researchers argued successful BMWM represents a challenge in their countries due to lack of awareness and trained clinical staffs in waste management framework. In addition, absence of BMWM guideline, legislation and unavailability of suitable treatment and disposal options may further obstruct waste management efforts [3].

Several studies in Africa indicated that BMWM is still in its infancy; characterized by the lack of awareness on the impacts of BMWs, total absence of medical waste regulations and a high incidence of non-compliance in cases where they are existing [5, 26, 27, 28]. Thus, the problem of BMW disposal in the hospital and other health care establishments has become an increasing issue of concern [29]. Despite the risk it imposes, BMWM in Ethiopia is a neglected activity by health service providers and lacked the attention it deserves.

Safety is an important element of quality system essentials and studies in the area of BMWM have been wide internationally. However, exploring the dynamics of KAP and associated factor scenarios especially in developing countries including Ethiopia have been so far overlooked. Credible evidences showed that BMWM across Ethiopian health institutions are still inadequate [21]. Studies conducted so far were mainly focused on waste generation rate and its management at a facility level while assessment of KAP and associated factors among HCWs were left behind especially among cleaners who play a critical role on reducing bio-hazardous associated risks. Studies conducted did not specifically report their result among job categories of HCWs [30] to establish specific strategy to mitigate issues related mismanagement of BMWs. The current study aimed at filling these gaps.

1.3 Significance of the study

The findings from the study will benefit clients, health care worker, health care facility managers, researchers, policy makers and other stakeholders as outlined below.

- It provides information for HCFs to identify level of KAP among health care workers and factors contributing to noncompliance with waste management guidelines. So that the health care facilities could design targeted interventions to ensure safety of the patients it serves, its staffs and other clients.
- The study also provides information for policy makers and stakeholders about existing situations of BMWM to plan measures to mitigate improper waste management.
- The study may identify gaps for researchers who would like to conduct detailed and comprehensive studies either in public or private health institutions.

1.4 Scope of the study

The study was focused on governmental and non-governmental HCFs found within Debre Markos town. Only BMWs generated from health care delivery sections were studied which means wastes generated from offices, kitchen houses and outside HCFs were excluded from this study. In this study wards, out patient departments (OPDs), laboratory rooms, emergency rooms and other sections which were potentially generated BMWs wastes were studied. This study was also limited to assess solid BMWs (blood or its derivative contaminated substances) such as; dressing, gauze, cotton, used intravenous sets, gloves, used specimens or their containers, needle and syringe and so forth. Health care professionals who were involved in the generation/segregation of BMWs (Laboratorians, Nurses, Medical doctors, Health officers (HOs) and Midwifes) and cleaners responsible for (collection, transportation, storage, treatment and disposal) of BMWs wre the study participants. Those HCPs were selected on the ground that they are the prominent producers of BMW and responsible for its segregation. Other HCWs were excluded from the study either due to their number or low involvement in BMWM. In addition, a three-bin system of waste segregation was assessed to suite different levels of HCFs and only on site waste treatment and disposal systems were assessed.

2. Literature review

Literatures related to KAP of BMWM both at global and regional levels were reviwed and discussed with Ethiopian perspective. Literatures were searched mainly from three online electronic databases (Science Direct, PubMed and Google scholar) and the search strategy was employed as follows; Databases were searched applying key words “biomedical waste” OR “medical waste” OR “clinical waste” OR “infectious waste” OR “hospital waste” OR “health care waste” OR “biomedical waste management” AND “knowledge” OR “attitude” OR “practice” AND “health care workers”. In addition, the search was repeated with the same keywords but including each African country. Sometimes direct Google search was also applied as appropriate.

A cross sectional study was conducted in 2015 among health care personnel at tertiary care hospital, India by Gupta. Among 200 study participants, 52% were working in hospital from 1 to 5 years followed by <1 year 29%, 6-10 years 12.5% and >10 years 6.5%. Knowledge score as satisfactory was highest among doctors (86%), followed by nursing staff (70%) and lab technicians (46%). The practice score of BMW management was satisfactory in most doctors (90%), nursing staff (78%) and lab technician (68%) and it was poor in 62% of sanitary workers. On the other hand, attitude score as satisfactory was highest among doctors (100%) followed by nurses (74%) and lab technicians (64%) and attitude scores as poor were among sanitary workers (54%) [31].

Radha conducted another cross-sectional study in India during 2012 and the result showed that doctors had better knowledge about BMW management compared to other categories except knowledge of disposal of sharps in blue colored puncture proof containers (31%) in which other categories had better knowledge. Only 16% of the sanitary staffs were aware of the diseases transmitted by BMW. The majority of sanitary staff felt that, management of BMW is not an issue at all and they felt that the safe management of BMW is an extra burden at work. The majority of nurses and lab technicians had favourable practices than other groups [32].

Further cross sectional study was conducted in Nainital, India by Kumar *et al* and the result showed that 87.3%, 86.4%, and 85.5% of HCWs were aware about transmission of HIV, Hepatitis B, and Hepatitis C through BMW respectively. About 70.9% nurses, 45.8% sanitary staff, 33.3% lab technicians and 31.4 % doctors had correct knowledge on disposal of infectious wastes in a yellow coloured bag. About 80.4% doctors, 65% nurses, 58.3% sanitary staff and 28.6% lab technician had known about disposal of BMW in blue/white container and 85.5% HCW were able to identify biohazards symbols. About 69.1% were immunized for hepatitis B. About 75% of the sanitary staff, 57.1% of lab technicians, 27.5% doctors and 11.7% nurses had not taken Hepatitis B vaccine. About

95% HCW used PPE while handling and disposal of BMW and 65.5% of HCWs (74.8% nurses, 78.8% sanitary staff, 54.9% doctors and 52.4% lab technicians) practiced segregation at source. In addition, 61.2% of nurses, 21.6% doctors and 9.5% lab technicians received training on BMW [13].

Ray *et al* conducted a cross sectional study in Kolkata, India during 2014 to assess knowledge attitude and practices of BMWM. Among 140 study participants, a significant gap was observed on the knowledge of doctors with regard to biomedical waste disposal in addition to this attitude and practice of BMWM among doctors was 73.12% and 77.81%, respectively. Similarly, overall rates of satisfactory knowledge, attitude and practice among nursing staff were 98.21%, 98.21% and 97.32%, respectively. Knowledge of BMW Management, attitude and practices among labs were 56.26%, 53.90% and 53.73% respectively. Among sweepers the overall knowledge, attitude and practice about BMW management were 36.25%, 37.5% and of 37.50%, respectively [33].

A descriptive cross sectional study was conducted in Iran during 2015 by Amouei. Among 130 study participants, 12%, 72% and 16% had low, medium and high knowledge, respectively towards hospital waste management where as 16% and 84% had medium and high attitude towards hospital waste management respectively. About 4%, 46% and 50% had low, medium and high practice respectively [34].

Uddin *et al* conducted a descriptive cross sectional study among nursing staff during 2014 in Bangladesh to assess their level of knowledge. Among 125 respondents, 18.4%, 26.4 %, and 55.2% had service less than 5 years, 5–10 greater than 10 years, respectively. Among respondents, 61.6% were trained about hospital waste management. Knowledge about general waste, infectious waste, biomedical waste and color-coded bins were 4%, 63.2% 7.2% and 46.4%, respectively whereas regarding knowledge about safe disposal of hospital waste 16% of them could not give any correct answer [35].

A cross sectional study was conducted in Nigeria during by Sabageh *et al* during 2015 and the result indicated that only 50.8% knew about color coding while 37.2% heard about segregation and 45.0% had good knowledge about healthcare waste management. Attitude of respondents was assessed using 3 point Likert scale and 83.8% of them felt health care waste management was their concern, but 37.2% felt healthcare waste management was the sole responsibility of cleaners. About 45.5% had positive attitude, while 54.5% had poor attitudes towards healthcare waste management. About 40.3% of the respondents practiced segregation of healthcare waste, 47.6% worked in centers with written policy on healthcare waste management, 31.4% had been trained on healthcare waste management, and open dumping was practiced by 35.6% followed by burning (23%) and burial (19.9%) [36].

Azuike *et al* conducted another cross-sectional study in Nigeria in 2015. Among 331 HCPs included, about 96.7% and 0.9% of them were tertiary and primary education, respectively. About 93% HCW were knowledgeable on the hazards of healthcare waste. Practice of discarding of sharps into the safety box was high [37].

Mbarki *et al* in Morocco carried out further study during 2015. Among 219 healthcare personnel and their assistants studied, housekeepers demonstrated higher knowledge on waste separation (49.4%) followed by nurses (45.7%), and doctors (38.6%). Practices of waste management in most surveyed hospitals did not comply with the principles stated in Moroccan legislation [38].

A cross-sectional study was conducted by Hakim *et al* in Egypt during 2014. Among 350 health-care personnel studied, 67.5% nurses, 38.2% physicians and 21.3% housekeepers received training on waste management. About 93.3% housekeeping staff knew existence of hospital and department plans for waste disposal. Physician's correct knowledge on the use of sharp boxes (51.8%) and identification of biohazard symbol (47.3%) was higher than nurses and housekeepers. About 68.3%, 60.9% and 40.4% of physicians, nurses and housekeepers had satisfactory knowledge scores, respectively. On the other hand, 84.0% nurses had satisfactory practice scores than physicians (67.3%). Housekeepers also had the highest overall scores for attitudes towards waste disposal [39].

A study was conducted at Adama city health care facilities in Ethiopia during 2014 by Hayleeyesus *et al* to assess health care waste generation rate and its management. Five HCFs were studied and the result indicated that most (75%) HCPs have knowledge of different categories of health care wastes, but only 37% knew color-coding system used for waste containers and 28% of HCPs knew the existence of HCWM guidelines. In addition, only 31% of HCPs had received training on safe HCWM practices. There was no segregation of healthcare waste by type at the point of generation. The use of a color coding system for HCW containers was not practiced and there was no labelling practice for hazardous waste. Furthermore, there was a low level of awareness about safe healthcare waste management. Health care waste was temporarily stored in plastic buckets. In addition to this, there was no practice of pre-treatment of infectious wastes in the studied HCFs. Open pit burning and single chamber incinerators were the most utilized final treatment methods [17].

During 2012 a cross sectional study was conducted in Gondar town by Yenesew *et al*. Among 260 HCWs studied, about 41.5% were nurse. About 30%, 38.1% and 31.9% had higher, moderate and lower knowledge on diseases transmission with healthcare waste, respectively; however, 77.7%, 17.3% and 5% had low, moderate and higher knowledge on healthcare waste types and color coding containers for healthcare waste and responsibility of healthcare waste segregation, respectively. About

96.9% of the HCWs did not access any guideline and 53.1% HCWs did not take any training on HCW as well. The prevalence rate of needle sticks/sharps injury in the preceding 12 months was 25%. HCWs reported that 31.5 % of them were doing healthcare waste management practice and 93% of the respondents used gloves during handling of healthcare wastes. Only 40.8% of respondents treated infectious wastes with sterilization, and disinfection before disposing off. Only 31.9% of respondents segregated wastes by type at point of generation and most respondents (88.5%) used the available waste bins for placing healthcare wastes [30].

A study conducted by Tesfahun Esubalew at Debre Birhan hospital indicated that segregation of health care wastes by type were not practiced. In addition, the study was more of descriptive it did not indicate proportions of HCWs' knowledge, attitude and practice score. This study was mainly focused on health care waste generation rate rather than assessment of knowledge, attitude and practices of health care professionals [40].

Similarly, a study was conducted in Hawassa city by Haylamicheal *et al* on assessment of health care waste management at a facility level. The result indicated that most HCFs did not practiced segregation of waste at their facility and only one HCF was used complete color coding system (yellow, black and safety box). However, even in that facility general waste was often mixed with infectious waste. In addition, most HCFs did not use safety boxes. Waste was transported mostly in open plastic containers from generation site to the treatment area and in most HCFs waste was collected from generation areas twice a day. As a treatment method, most HCFs use low combustion, single chamber, and brick incinerators. None of the HCFs reported employing other waste treatment options such as autoclaving, steam sterilization, microwave irradiation or chemical disinfection. Most of them were exercised open dumping of incinerated ash; moreover, waste handlers experienced needle-stick injuries at least once in their life ranged from 25-100%. Moreover, all HCFs reported that they had never given any immunization/ vaccination to their waste handlers [18]. A study conducted by Azage and Kume in Amhara region health centers was also mainly focused on health care waste generation rate [21]. In general, in Ethiopia studies on BMWM were skewed to generation rates rather than measurement of HCWs' KAP aspect. Generally, studies conducted in Ethiopia indicated that health care waste generation rates were high which may increase risk of infection. Therefore, attention on KAP studies of HCWs may be able to identify important gaps of knowledge, attitude and practices to design appropriate intervention.

3. Conceptual framework

To establish a conceptual framework, this paper looked three main domains (Knowledge, Attitude and Practice) in relation to predictor variables (socio demographic and HCF related factors). Figure 1 illustrates relationships between socio demographic and HCF related factors with HCWs' knowledge, attitude and practice towards BMWM. Socio demographic factors such as work experience, educational level, type of job may influence HCWs level of knowledge, attitude and practice for BMWM. Similarly, HCF related factors such as availability three types of waste bins, guideline/ operational documents, visual aid, designated individual/BMWM committee in the facility, working hours per day, etc. could also influence their level of knowledge, attitude and practice as well. Health care workers' knowledge can in turn affect their level of practice on BMWM and level of attitude may have an impact on their knowledge and practices as well. Finally, practice on BMWM may have an influence on knowledge, attitude and outcomes of BMWM.

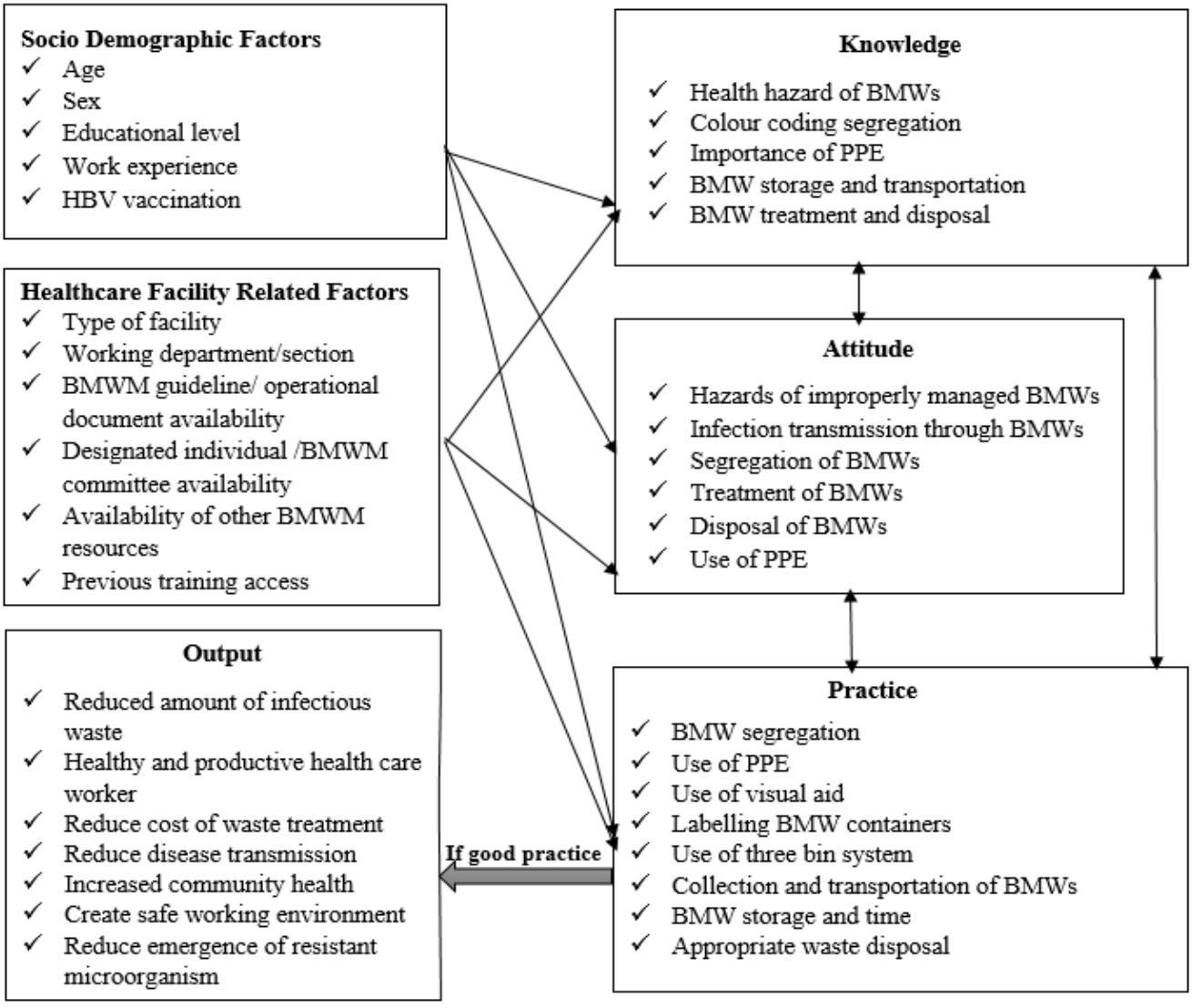


Figure 2. Conceptual framework showing relationship of predictor and outcome variables

4. Objectives of the study

4.1 General objective

- To assess knowledge, attitude and about bio-medical waste management and associated factors among health care workers at Debre Markos town health care facilities, Northwest Ethiopia

4.2 Specific objective

- To measure level of knowledge towards biomedical waste management among health care workers at Debre Markos town health care facilities
- To assess level of attitude towards biomedical waste management among health care workers at Debre Markos town health care facilities
- To assess level of practice towards biomedical waste management among health care workers at Debre Markos town health care facilities
- To assess associated factors of knowledge, attitude and practice towards biomedical waste management

5. Materials and method

5.1 Study area and setting

The study was conducted at Debre Markos town HCFs. Debre Markos is a Zonal town, which is found in Amhara regional state at a distance of 305 km far from Addis Ababa to Northwest Ethiopia**.** One referral hospital, 4 health centers and 12 clinics were geographically found within the town. The hospital has five in-patient wards (gynecological and obstetric, surgical, medical, pediatric and eye unit). According to Debre Markos referral hospital human resource department report, during 2016/17 there were 35 doctors, 144 nurse, 25 midwiferies, 33 medical laboratory professionals. In addition to this, the hospital management has outsourced waste cleaners to a private business and 33 cleaners were currently working as a fulltime employee. Currently the hospital has 400 inpatient beds and acts as a referral center for general hospitals in the area and serves 5 million inhabitants [41]. According to Debre Markos town district health office report, during 2016/17 health centers had 15 laboratory professionals, 39 nurses, 11 midwives, 16 HOs, and 11 cleaners. Among clinics, seven of them were specialized clinics and 2 clinics were owned by non-governmental organization. Similarly, 12 clinics in total have 8 laboratory professionals, 18 nurses, 8 HOs and 15 cleaners. Health centers and clinics are providing health services for the town and nearby areas.

5.2 Study design and period

An institutional based cross sectional study was employed from November 20, 2016 to June 12, 2017

5.3 Sample size determination

A single population proportion formula was used to calculate the sample size by considering an assumption of 50% proportion, 95% level of confidence and 5% margin of error then the sample size of the study was calculated as follow.

$$n_i = \frac{(Z\alpha/2)^2\, pq}{d2}$$

$$n_i = \frac{(1.96)2\ 0.5(1\text{-}0.5)}{(0.05)^2}$$

$$n_i = 384$$

The initial sample size was calculated to be 384. Since the source population was <10,000, reduction formula was used to estimate the final number of study populations included in the study.

$$n_f = \frac{n_i}{(1+\frac{(n_i)}{N}} = \frac{384}{(1+\frac{(384)}{412}}$$

$n_f = 199$

Assuming 10% non-response rate

199 *0.1 = 219

$n_f = 219$

However, since the study population was small enough (412) which is manageable, all the study population who fulfilled the eligibility criteria were included in the study.

5.4 Eligibility criteria

- All HCPs (doctors, labs, nurses, HOs and midwives) and cleaners in the studied HCFs with at least one year of experience.
- Potential participants who only available during data collection period
- Only permanent employee in that specific facility were included
- Participants who only consent to take part in the study were included

5.5 Variables of the study

5.5.1 Dependent variables

- Knowledge
- Attitude
- Practice

5.5.2 Independent variables

- **Socio demographic factors**
  - Sex
  - Age
  - Educational level
  - Stream of education
  - Work experience
- **Health care facility related factors**
  - Personal protective equipment
  - Previous training access on BMWM
  - BMWM guideline/ operational document
  - Designated individual/BMWM committee
  - Waste treatment and disposal systems
  - BMWM information source
  - Assigned working department/ section

- Availability and use of all three bins
- Working hour per day
- Presence of visual aid
- BMW storage time
- Type of HCF

5.6 Study participants

Health care professionals (doctors, nurses, labs, midwifes, HO and cleaners were studied. These categories were chosen on the ground that they are large in number per their job category and mostly they are involved in either BMW generation/segregation or come in contact with the infectious waste more often during subsequent management than other staff. Which means other HCPs or support staffs were excluded due to either their few in number or low involvement in BMWM process. In this study, 351 HCWs (296 HCPs and 55 cleaners) were included from 14 HCFs (1 hospital, 4 health centers and 9 clinics) found in the town after excluding those HCFs and potential participants who were not willing to participate (27) and other non-illegible study participants (34). Among clinics included in the study, four of them were specialized clinics while the remaining were medium sized clinics. In addition, two clinics were owned by non-governmental organizations. Three private clinics were excluded from the study because two of them were refused at a facility level with three study participants and employees of the other clinic were permanent employee of the hospital.

5.7 Data collection tools and procedure

5.7.1 Data collection tools

Data collection tools were structured self-administered questionnaire for HCPs and interviewer-administered questionnaire for cleaners assuming their education level might be limited. For both cases observation checklists were used to confirm their actual practices. In addition, facility observation checklist was prepared to assess mainly BMW storage, treatment and disposal activities. Data collection tools were prepared in English and Amharic languages. In both cases they were prepared as simple and user-friendly as possible.

5.7.1.1 Questionnaire

The questionnaire was developed by the principal investigator and advisors from review of available scientific literatures [36, 39, 42]. Both national and international guidelines were also revised to suite the study population [2, 10, 11, 43]. Questionnaires were consisted of four sections:

Section I: Contain socio-demographic and HCF related data such as age, sex, religion, educational level, job category, HCF type, marital status, availability of designated individual or BMWM

committee, guidelines, work experience, working hour per day and department /section or unit of work.

Section II: Contain structured self-administered and interviewer administered knowledge questionnaire sheet. It contains questions covering awareness about BMWM, segregation BMWs, needle stick/sharp injury, labelling and color condign of BMW containers, use of personal protective equipment, BMW disposal methods, maximum storage time of infectious BMWs, transportation of BMWs, universal biohazard symbol, volume of a safety box to be filed, yellow bin, black bin.

Section III: Contain questions used to measure attitude of study participants about BMWM focused on disease transmitted through BMWs, proper handling of BMWs, wearing personal protective equipment, segregation and containers used for BMW segregation, issue of BMWM, disinfection and disposal of BMWs, HIV post exposure prophylaxis, BMW container.

Section IV: Separate questionnaires were prepared to measure practices of HCPs and cleaners due to obvious difference of their practices. HCPs are mostly involved in the generation and separation of BMWs whereas cleaners are involved in the collection, storage, treatment and final disposal of BMWs.

5.7.1.2 Observation checklist

Individual observational checklists were mainly focused availability of PPE, waste segregation materials and individual activities towards waste separation, collection and transportation accordingly. Whereas facility observational check list was focused on waste storage, treatment and final disposal. This is because for waste storage, treatment and disposal activity only one individual or some of them may be involved hence observational measurement is better to address this issue. For both cases each item was checked as yes if the activity done correctly or no if not done correctly.

5.7.2 Data collection procedure

Data were collected using pretested self-administered structured questionnaire for health care professionals and face-to-face interview (interviewer administered structured questionnaire) for cleaners. In both cases, observation checklists were used to cross check real practices of BMWM in the actual situation. After obtaining an informed consent, questionnaires were distributed as hard copies for HCPs. whereas face-to-face interviews were done for cleaners as they may have difficulties in reading or understanding especially medical terms used in the questionnaire. After interviewing or collecting questionnaires, data collectors checked each questionnaire for completeness and incomplete questionnaires were taken back immediately to the respondent for completion and then data collectors observed the study participants and filled observation checklists while study participants were providing services. Finally, observation checklists and questionnaires were labelled with similar HCF and individual identification code numbers and observation checklists were immediately attached to

the end of the corresponding questionnaire to facilitate incorporation of all data for the same person in one sheet.

5.8 Methods of measurement (scoring)

In this study, all questions were close-ended. The questionnaires were containing three main domains (Knowledge Attitude and Practice).

I. Knowledge domain

This domain consisted of 21 multiple-choice questions. Each item had either three answer or four answer options. Knowledge scores were dichotomized by giving "1 point" or "0 point" which means each right or expected response was given a score of "1 point" whereas a "wrong," "unsure" or "unexpected" response was given "0" point. To clarify those questions with response options like always, sometimes and never the expected response is always in this case if the study participant responds "always" then he/she can have got "1 point" otherwise zero point. Total knowledge scores were computed for each participant. Possible composite knowledge scores for an individual could range from 0 to 21.

II. Attitude domain

Comprised of 16 Likert items in which study participants could indicate their degree of agreement towards a given statement. A five point Likert scale of measurement was used to represent scores, as such "Strongly Disagree", "Disagree", "Neutral", "Agree" and "Strongly Agree" and were given numerical scores 1, 2, 3, 4 and 5, respectively. For those items, which were negatively phrased statements, scores were reversely coded during data entry as 5, 4, 3, 2, and 1 for category "Strongly Disagree", "Disagree", "Neutral", "Agree" and "Strongly Agree", respectively. A positive attitude is considered when a person agreed to a favourable outcome or disagree when behaviour which has negative impact on BMWM. Finally, composite scores for each individual were calculated by adding the whole Likert item responses together for an individual. Possible attitude composite scores for an individual could range from 16 to 80.

III. Practice domain

Due to their obvious difference among HCPs and cleaners regarding BMWM practice, separate questions were prepared for them. Nine and six multiple-choice questions were prepared for HCPs and cleaners respectively. Practice scores were dichotomized by giving "1 point" or "0 point". Which means each practice question is assigned "1" when the activity is done correctly where as "0" was provided for incorrect practice. Hence, the composite practice score could range from 0 to 9 for HCPs and 0 to 6 for cleaners. For all three domains, individual composite scores were summed up together. Mean scores were calculated by dividing the overall composite score by the number of respondents in

that domain. Then mean score was considered as a cut point to categorize KAP scores. Finally, KAP scores were bifurcated into two categories to compare our findings with other studies, which means using frequency distribution KAP scores below mean were considered as inadequate knowledge, negative attitude or inadequate practice whereas scores mean and above were considered as adequate knowledge, positive attitude or adequate practice.

5.9 Data quality measures

Questionnaires were developed after reviewing guidelines and available literatures of similar studies to suite the study population. They were first prepared in English and then translated into Amharic and back to English to ensure correctness of translation.

5.9.1 Content validity

Questionnaires and observation checklists were validated with pilot survey of 10% of similar study population at Lumame District HCFs. According to the pilot survey, contents of questionnaires and observation checklist were slightly modified and suggestions from different persons were included in the final questionnaire.

5.9.2 Reliability

Questioners and observational checklists were structured hence there is no inter data collector variability. Study participant selection bias was bypassed due to whole population sampling techniques. Training was given for three data collectors on how to approach study participants and on spot-checking during data collection was done on daily bases. In addition, on each data collection day, the collected data were reviewed for completeness and amendments were made before the next data collection day. In addition, exclusion criteria were considered during data collection time. To maintain quality data entry, data were entered into Epi-data 3.1 software due to its stringent nature to maintain quality data entry.

5.9.2.1 Internal consistency reliability

Internal consistency was analysed using Chronbach's Alpha coefficient. The overall Chronbach's Alpha value among HCPs and cleaners were 0.827 and 0.716 respectively. Thus in both cases internal consistencies of questioners were acceptable because Chronbach's Alpha coefficients were high i.e. more than 0.7.

5.10 Data management and analysis

The collected data were coded and entered into Epi-data 3.1 statistical software and then exported to SPSS version 20 for analysis. Descriptive statistics was computed through cross tabulation and summary tables were generated. Bivariate and multivariable logistic regression analyses were computed to identify predictor variables having significant association with the outcome variables. Odds ratio with 95% confidence interval was used to determine the strength of association between predictor and outcome variables. For this study all variables having p value ≤ 0.2 were entered into the multi variable logistic regression model to adjust possible confounders and then their strength of association was measured with odds ratio (OR). Variables having p value of < 0.05 in the final analysis (multivariable logistic regression model) were considered to explain the presence of association. In this study cleaners practice were assessed with Chi square and Fisher's Exact tests to indicate presence of significant associations (p value < 0.05) however; their strength was not measured due to small number of study participants in that category. In addition, qualitative findings from HCF observation checklist were paraphrased. Results of the study were presented in the form of texts and tables as appropriate. Finally based on the result of the study conclusions and recommendations were forwarded.

5.11 Ethical considerations

Ethical approval was obtained from the Departmental Research and Ethics Review Committee (DRERC) of the department of Medical Laboratory Science, Addis Ababa University. Official letters were written from east Gojjam Zonal health department office to Lumame district HCFs, Debre Markos referral hospital and Debre Markos district health office. The district health office again wrote letters to Debre Markos town HCFs. Permission was obtained from hospital manager; heads of health centers and non-governmental HCFs. Study participants were informed about the purpose of the study. Confidentiality was maintained at all levels of the study. Participants' involvement in the study was based on voluntary basis and participants who were unwilling to participate in the study and those who wish to quit their participation at any stage were informed to do so without any restriction.

5.12 Dissemination of the result

Results of this study will be presented in the form of thesis defence at Addis Ababa University and on other professional association meetings. Publication will be attempted on scientific journals. Finally, the hard copies of the study will be distributed to Addis Ababa University, postgraduate office, East Gojjam Zone Health Department and district health offices, and Debre Markos referral hospital.

6. Result

6.1 Socio-demographic and HCF related characterstics

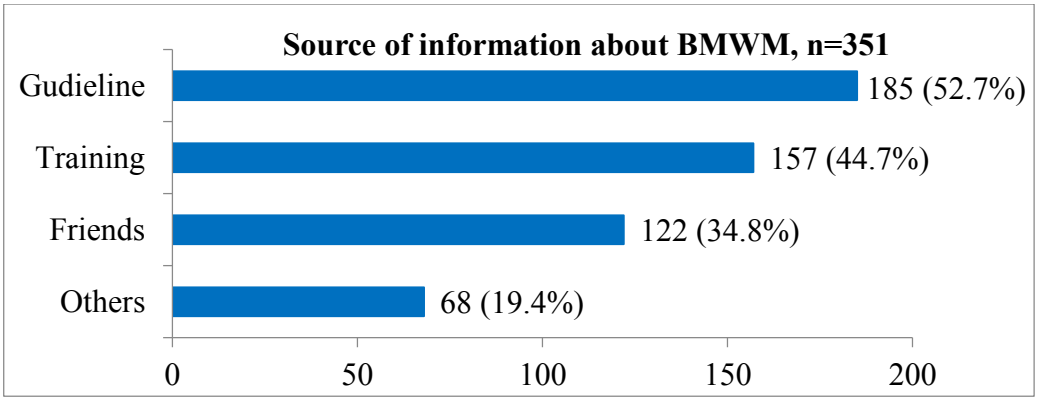
Three hundred fifty-one study participants (with 93.4% response rate) were included from 14 HCFs from which 226(64.4%), 81(23.1%) and 44(12.5%) were included from the hospital, health centers and clinics respectively. Age of study participants was ranged from 19 to 56 years. In addition, most of them were working at OPD followed by ward and less than one third (29%) were vaccinated for HBV. Regarding previous training access, only 126(36%) of study participants had taken BMWM training. In addition, 86(24.5%) of the study participants had encountered needle stick injury during the previous 12 months. Moreover; 287(97%) HCPs respond availability of sufficient quantity glove at their department/ working section. Similarly, 52(94.6%) and 48(87.3%) of cleaners reported availability of heavy-duty gloves and aprons at their facility, respectively; however, none of them reported availability of boots. Most HCPs 241(81.4%) respond availability of all 3 types of color coded bins at their department/ section [Table 1].

Health care workers' response regarding their source of information about BMWM is depicted in Figure 3. As shown in the figure, over half of them (185/351, 52.7%) responded guideline as their source of information while 44.7% (157/351) got the information from trainings and a good proportion, 34.8%, (122/351) got information about BMWM from friends.

Table 1. Socio demographic and HCF related factors for BMWM at Debre Markos town HCFs, Northwest Ethiopia, June 2017 (n=351).

Socio demographic and HCF related variables	Variable category	Study participant n (%)
Gender	Male	177 (50.4)
	Female	174 (49.6)
Age of respondents	≤ 25 years	84 (23.9)
	26-30 years	167 (47.6)
	31-35 years	44 (12.5)
	>35 years	45 (12.8)
	Missing	11 (3.1)
Educational level	MSc	20 (5.7)
	BSc and above	170 (48.4)
	Diploma and certificate	131 (37.3)
	Secondary and below	30 (8.5)
Job category	Doctor	31 (8.8)
	Nurse	163 (46.4)
	Midwife	27 (7.7)
	Lab	49 (14)
	HO	26 (7.4)
	Cleaner	55 (15.7)
Working department/ section #	OPD	127 (36.2)
	Ward	113 (32.2)
	Lab room	75 (21.4)
	Emergency	82 (23.4)
	Others	106 (30.2)
Work experience	1-5 years	192 (54.7)
	6-10 years	100 (28.5)
	>10 years	53 (15.1)
	Missing	6 (1.7)
Working hours per day	<8 hours	14 (4)
	8 hours	272 (77.5)
	>8 hours	56 (16)
	Missing	9 (2.6)
BMWM guideline/ operational document availability (n=296)	Yes	159 (51.6)
	No	101(34.1)
	Not sure	36 (12.2)
Availability of designated individual/ BMWM committee (n=296)	Yes	188 (63.5)
	No	57 (19.3)
	Not sure	51 (17.2)

Key: ***#*** *denoted multiple response questions. Frequencies and proportions were out of the total 351 for each working department/ section.*



Note: *Values on the bar chart are frequencies and proportions out of the total 351 for each source of information.*

Figure 3. Health care workers' response regarding their source of information about biomedical waste management.

6.2 KAP scores of study participants

The over all adequate knowledge, positive attitude and adequate practice scores were 193 (55%), 218(62%) and 277(79%) respectively. More specifically, the higest adequate knowledge score was noted among laboratory professionals 35(71.4%) and the list was among cleaners 25(45.5%). Doctors had the highest 25(81%) positive attitude score followed by health officers 19(73.1%) while the list acore was among cleaners 22(40%). Regarding practice scores, midwifes had the higest practice score 25 (92.6%) followed by cleaners 48 (87.3%) but doctors had the list 18(58.1%). Details are shown in Table 2.

Table 2. KAP percentage distribution of study participants based on their knowledge score about BMWM at Debre Markos town HCFs, Northwest Ethiopia, June 2017 (n=351).

KAP category		Job category n (%)						Total (n=351)
		Doctor (n=31)	Nurse (n=163)	Midwife (n=27)	Lab (n=49)	HO (n=26)	Cleaner (n=55)	
Knowledge	**Adequate**	19(61.3)	80(49.1)	16(59.3)	35(71.4)	18(69.2)	25(45.5)	**193(55.0)**
	Inadequate	12(38.7)	83(50.9)	11(40.7)	14(28.6)	8(30.8)	30(54.5)	**158(45.0)**
Attitude	**Positive**	25(80.6)	102(62.6)	17 (63.0)	33(67.3)	19(73.1)	22(40)	**218(62.1)**
	Negative	6(19.4)	61(37.4)	10(37.0)	16(32.6)	7(26.9)	33(0.6)	**133(37.9)**
Practice	**Adequate**	18(58.1)	126(77.3)	25(92.6)	40(81.6)	20(76.9)	48(87.3)	**277(78.9)**
	Inadequate	13(41.9)	37(22.7)	2(7.4)	9(18.4)	6(23.1)	7(12.7)	**74(21.1)**

Key: *KAP: knowledge, attitude, practice; Lab: laboratory; HO: health officer*

6.2.1 Knowledge of study participants

Frequency of study participants among each knowledge question is indicated in [Table 3]. Only 188(54%) study participants identified the biohazard symbol. Regarding segregation of BMWs, about 255(73%), 275(78%) and 303(86%) study participants were aware that general, infectious and sharp wastes should be placed in a black, yellow and safety box, respectively. In addition, 291(83%) were aware of a safety box should be filled a maximum of $3/4^{th}$. Only 36(10%) of study participants knew maximum storage time limite of infectious wastes before treatment or disposal while 236 (67%) knew 72 hours as a maximum time delay to start HIV post exposure prophylaxis. Detailes of knowledge status of study participants on BMWM are shown in table 3.

Table 3. Frequency of study participants among each knowledge item question at Debre Markos town HCFs, Northwest Ethiopia, June 2017 (n=351).

Variables	Job category n (%)					
	Doctor (n=31) (yes)	Nurse (n=163) (yes)	Midwife (n=27) (yes)	Lab (49) (yes)	HO (n=26) (yes)	Cleaner (n=55) (yes)
Does your facility generate BMWs?	24(77.4)	129 (79.1)	24(88.9)	43(87.8)	26(100)	55(100)
Do you now about BMWM?	24(77.4)	113(69.3)	20(74.1)	38(77.6)	24(92.3)	52(94.5)
Is there any health hazed associated with BMWs?	30(96.8)	148(90.8)	24(88.9)	43(87.8)	24(92.3)	54(98.2)
Is needle-stick/sharp injury a concern?	31(100)	147(90.2)	25(92.6)	43(87.8)	25(96.2)	54(98.2)
Does wearing PPE reduce risk of infection?	29(93.5)	149(91.4)	26(96.3)	47(95.9)	25(96.2)	52(94.5)
Are all BMWs biologically hazardous (infectious)?	23(74.2)	99(60.7)	21(77.8)	40(81.6)	14(53.8)	40(72.7)
Are body fluid contaminated items consider as BMW?	31(100)	134(82.2)	26(96.3)	45(91.8)	23(88.5)	39(70.9)
Do you know about color coding segregation of BMWs?	26(83.9)	120(73.6)	21(77.8)	40(81.6)	20(76.9)	44(80.0)
Should infectious waste containers be label with biohazard symbol?	24(77.4)	126(77.3)	23(85.2)	35(71.4)	25(96.2)	35(63.6)
Should BMWs segregate at the point of generation?	25(80.6)	137(84.0)	22(81.5)	40(81.6)	24(92.3)	48(87.3)
Does disinfection of BMWs decrease infection transmission?	27(87.1)	159(97.5)	27(100)	47(95.9)	26(100)	53(96.4)
Do we need to close BMW containers while transport?	27(87.1)	127(77.9)	21(77.8)	38(77.6)	24(92.3)	50(90.9)
Do we need to secure BMWs awaiting for treatment/ disposal?	26(83.9)	132(81)	24(88.9)	39(79.6)	19(73.1)	50(90.9)
Do you know about BMW disposal methods?	23(74.2)	98(60.1)	21(77.8)	33(67.3)	22(84.6)	48(87.3)

Note: *n (%) indicate proportion of study participants correctly answered for each knowledge questions; BMW: biomedical waste; BMWM: biomedical waste management; Lab: laboratory; HO: health officer*

6.2.2 Attitude of study participants

The mean attitude score of Likert items was ranged from 3.80 to 4.45. In addition, 161(45.9%) study participants strongly agreed to the statement 'BMWs should be segregated into different categories at the point of generation' and 191(58.1%) study participants agreed to the statement 'safe BMWM is an issue involving a team work'. However; to make similar category with other studies for discussion later on the five point Likert scale items were categorized into three level Likert scale (agree, neutral and disagree) as it is indicated in [Table 4]

Table 4. Frequency distribution of study participants among each Likert item of BWM at Debre Markos town HCFs, Northwest Ethiopia, June 2017 (n=351).

Predictor variables	Response options		
	Disagree n (%)	Neutral n (%)	Agree n (%)
Improperly managed BMWs may cause infection	29(8.3)	8 (2.3)	314(89.4)
Proper BMW handling is an issue	28(8)	4 (1.1)	319(90.9)
Safe BMWM is an issue involving a team work	21(6)	17 (4.8)	313(89.2)
HIV may be transmitted through BMWs	27(7.7)	1 (0.3)	323(92)
HIV post exposure prophylaxis help to prevent development of HIV infection	29(8.3)	8 (2.3)	314(89.4)
HBV may be transmitted through BMWs	17(4.8)	12 (3.4)	322(91.7)
HCV may be transmitted through BMWs	36(10.3)	45 (12.8)	270(76.9)
BMWs do not transmit any infectious diseases	34(9.7)	13 (3.7)	304(86.6)
BMWs should be segregated into different categories at the point of generation	32(9.1)	16 (4.6)	303(86.3)
BMW segregation facilitate safe handling	32(9.1)	10(2.8)	309(88)
Labelling BMW containers have no significance	55(15.7)	14 (4)	282(80.3)
Proper BMW disposal is important to prevent infection transmission	22(6.3)	1 (0.3)	328(93.4)
BMW disinfection can reduce the chance of contracting infection	24(6.8)	11 (3.1)	316(90)
Wearing personal protective equipment helps to reduce risk of infection	20(5.7)	4 (1.1)	327(93.2)
BMWM add extra burden of work	81(23)	22 (6.3)	248(70.7)
Bio hazardous wastes should be disinfected before disposal	68(19.4)	24 (6.8)	259(73.8)

Key: *n (%) indicate frequenciec and proportions out of the total 351 for each likert itemquestion.*

6.2.3 Practice of study participants (segregation, collection and transportation)

This study revealed that 174(58.8%) of HCPs used visual aid at their health care service delivery section. Regarding use of PPE, 277(94%) and 288(97%) HCPs always used gloves and gown while handling or working with BMWs. Similarly, 44(80%) and 42(72.7%) cleaners always used duty gloves and apron respectively but none of them used boot. About 288(79.1%) HCPs practiced labelling BMW containers. Regarding segregation of BMWs, 275(92.9%) of HCPs practiced segregation of BMWs at the source. However; 261(88.2%) of them followed color coding segregation. Of these, 228(77%), 198(66.9%) and 247(83.4%) HCPs put general, infectious and sharp wastes into black bin, yellow bin and safety box respectively. More specifically 26(83.9%), 140(85.9%), 27(100%), 45(91.8%) and 23(88.5%) doctors, nurse, midwife, labs and HOs respectively followed color coding segregation. All cleaners collected BMWs from service areas within 24 hours and 50(90.9%) of them transport BMWs separately. Most cleaners 48(87.3%) close BMW containers while they transport them and 49(89.1%) disinfect cleaning devices after cleaning.

6.3 Observation result

6.3.1 Individual practice observation result

About 226(76%) HCPs were segregating BMWs at the source of generation. Similarly, 225 (75%) were using biohazard labelled safety boxes for sharp waste segrigation. On the other hand, about 70(27.2%) and 69(23.3%) HCPs were using yellow and black bins containing mixed wastes, respectively. About one fourth (25%) HCPs were working with at least one unlabled BMW conatainers and 65(22%) HCPs were observed using more than 3/4th filled infectious waste containers as well. Cleaners' observation result indicated that, about 46(83.7%) and 48(87.3%) cleaners were using heavy-duty glove and apron respectively but none of them used boot while cleaning/ working with BMWs. Forty-seven (85.5%) cleaners were transporting BMWs as they were segregated however, only 32(58.2%) were transporting in closed containers. About 25(45.5%), 8(14.5) and 28(50.9%) cleaners were using trolley, closed bucket and open bucket for transporting BMWs, respectively. Observational result and study participants' self-reports were more or less comparable on use of visual aid, gown, gloves, collecting BMWs from service area and disinfection of transporting devices.

6.3.2 Facility observation result (BMW storage, treatment and disposal)

In all HCFs 14(100%) there were no specifically designed waste storage areas and most of them 13 (93%) used puncture resistant waste bins where as one HCF 1(7%) used incinerator chamber as a temporary waste storage means. Waste treatment activity in most non-governmental HCFs was not based on time restriction rather amount of waste stored hence they were storing infectious wastes more than two days. In addition, all facilities 14(100%) used on site treatment methods among these 10

(71%) used incineration only to burn infectious and general wastes. One HCF (7.1%) used both incineration and open pit burning to burn infectious and general wastes, respectively; two HCFs (14.3%) used open ground burning and the other used open pit burning only. Four governmental and four non-governmental HCFs used incinerators made from local brick. Three non-governmental HCFs were using small scale (oil drum) incinerators. Other than incineration and burning, none of them used other types of waste treatment methods. Empirical observation indicated that incinerators of most non-governmental HCFs had remnants of incompletely burned waste materials. All studied HCFs disposed BMWs onsite; however, most of them 14(93%) did not have specifically designed ash pit hence they dispose either in the placenta pit, latrine opening or open dumping near the incinerator. Four HCFs (28.5%) did not fence their burning area/incinerator and they were easily accessible. Moreover, none of them used other types of waste disposal methods than pit burial or open dumping of treated BMWs.

6.4 Associated factors with KAP scores of study participants towards BMWM

6.4.1 Factors associated with knowledge scores of study participants

In the bivariate analysis, sex, age group, educational level, working in other department/section and attitude category of study participants were marginal where as job category, working in ward department, working in laboratory, work experience, information source from guideline, information source from training, presence of designated individual/ BMWM committee in the facility, availability of guideline/ operational document, availability of all the three color coded bins, previous training access and HCPs practice score showed statistical significant association with knowledge scores of study participans as stated in detail [table 5]. After after adjustment of possible confounders, > 10-year work experience (AOR 4.28), age group of 26-30- years (AOR 3.20), working in ward department (AOR 2.81), information source from training (AOR 1.98) and availability of all the three color coded bins in the department/ working section (AOR 3.56) were more likely to contribute for adequate knowledge score compared to the respective reference groups given that other variables were held constant. But sex, job category, previous training access, educational level, availability designated individual/BMWM committee, availability of guideline/ operational document, attitude and practice scores of HCPs did not show significant association with knowledge score of study participants in the multivariable logistic regression analysis [Table 5].

Table 5. Bivariate and multivariate logistic regression of factors associated with knowledge scores among study participants at Debre Markos town HCFs, Northwest Ethiopia, 2017 (n=351).

Variables			Knowledge		COR(95%CI)	P-value	AOR (95%CI)
			Inadequate (n)	Adequate (n)			
Sex		Male	71	106	1.49 (0.98,2.28)	.063	
		Female	87	87	1	1	
Age group		≤25 years	50	34	.50 (.24, 1.04)	.062	
		26-30	67	100	1.09 (.56, 2.13)	.799	3.20 (1.08, 9.48)*
		31-35	14	30	1.57 (.66, 3.73)	.311	
		≥36 years	19	26	1	1	1
Job category		Doctor	12	19	1.90 (.78, 4.66)	.161	
		Nurse	83	80	1.16 (.63, 2.13)	.642	
		Midwife	11	16	1.75 (.69, 4.44)	.242	
		Lab	14	35	3.00 (1.33, 6.78)	.008	
		HO	8	18	2.70 (1.01, 7.25)	.049	
		Cleaner	30	25	1	1	
Educational level		≥MSc	4	16	3.50 (.95, 12.97)	.061	
		BSc	81	89	.96 (.44, 2.09)	.921	
		Diploma & certificate	59	72	1.07 (.48, 2.37)	.872	
		≤Secondary	14	16	1	1	
Department	Ward	Yes	61	49	1.8 (1.14, 2.83)	.011	2.81 (1.42, 5.56)*
		No	97	144	1	1	1
	Lab.	Yes	28	53	.58(.34, .98)	.044	
		No	130	140	1	1	
	Other	Yes	53	51	1.41 (.89, 2.22)	.143	
		No	105	142	1	1	
Work experience		1-5 years	104	88	1	1	1
		6-10 years	32	68	2.51 (1.51, 4.17)	0.001	
		>10 years	20	33	1.95 (1.05, 3.64)	0.036	4.28 (1.40, 13.11)*
Information source	Guideline	Yes	74	111	1.54 (1.01, 2.35)	.047	
		No	84	82	1	1	
	Training	Yes	53	104	2.32 (1.50, 3.58)	.001	1.98 (1.05, 3.73)*
		No	105	89	1	1	1
Training		Yes	45	81	1.82 (1.16, 2.84)	.009	
		No	113	112	1	1	
Presence of designated individual or BMW committee (n=296)		Yes	72	116	1.74 (1.08, 2.80)	.024	
		No and not sure	56	52	1	1	
Guideline/ operational document availability (n=296)		Yes	54	105	2.28 (1.43, 3.65)	.001	
		No and not sure	74	63	1	1	
Availability of all 3 color coded bins (n=296)		Yes	91	150	3.39 (1.82, 6.30)	0.001	3.56 (1.60, 7.92)*
		No	37	18	1	1	1
Attitude score		Negative	68	65	1	1	
		Positive	90	128	1.49 (.96, 2.30)	.073	
HCP practice score (n=296)		Inadequate	38	90	1	1	
		Adequate	29	139	2.02 (1.17, 3.51)	.012	

Key: ** statistically significant at P-value <0.05; COR: crude odds ratio; CI: confidence interval; AOR: adjusted odds ratio. Those with p value 0.2 and less than were entered into the multivariate regression model.*

6.4.2 Factors associated with attitude scores of study participants

In the bivariate analysis, working in other department, information source from training and knowledge score of study participants were marginal and sex, information source from guideline, educational level, working hours per day, type of facility and job category were showed significant association with attitude scores of study participants. After adjustment of possible confounders, information source for BMWM from guideline/operational document exhibited 1.99 times more likely to contribute for positive attitude than those who do not use guideline/operational document given that other predictor variables were holding constant. Similarly, working 8 and more than 8 hours per day were also 7 and 6.6 times, respectively, more likely to contribute for positive attitude than working less than 8 hours per day. However; sex, working in other department/section, educational level, job category and knowledge score of study participants did not show significant association with attitude score of study participants [Table 6].

Table 6. Bivariate and multivariate logistic regression of factors associated with attitude scores of study participants at Debre Markos town HCFs, Northwest Ethiopia, 2017 (n=351).

Variables			Attitude		COR(95%CI)	P-value	AOR (95%CI)
			Negative (n)	Positive (n)			
Sex		Male	52	125	2.09 (1.35, 3.25)	.001	
		Female	81	93	1	1	
Other department/ section		Yes	45	59	1.37 (.88, 2.16)	.179	
		No	88	159	1	1	
Information source	Guideline	Yes	53	132	2.32 (1.49, 3.60)	.001	1.99 (1.19, 3.34)*
		No	80	86	1	1	1
	Training	Yes	53	104	1.38 (.89, 2.13)	.151	
		No	80	114	1	1	
Educational level		≤ MSc	4	16	6.91 (1.84, 25.96)	.004	
		BSc	44	126	4.95 (2.18, 11.21)	.001	
		Diploma and certificate	66	65	1.70 (.75, 3.85)	.203	
		≤ Secondary	19	11	1	1	
Working hour per day		< 8 hours	12	2	1	1	1
		8 hours	96	176	11.0 (2.41, 50.17)	.018	7.0(1.41, 34.88)*
		>8 hours	22	34	9.27 (1.89, 45.48)	.029	6.6 (1.25, 35.00)*
Type of facility		Hospital	71	157	2.65 (1.38, 5.12)	.004	2.87 (1.29, 6.41)*
		Health center	38	41	1.30 (.62, 2.71)	.494	
		Clinic	24	20	1	1	1
Job category		Doctor	6	25	6.25 (2.21, 17.71)	.001	
		Nurse	61	102	2.51 (1.34, 4.69)	.004	
		Midwife	10	17	2.55 (.99, 6.59)	.053	
		Lab	16	33	3.09 (1.38, 6.92)	.006	
		HO	7	19	4.07 (1.47, 11.30)	.007	
		Cleaner	33	22	1	1	
Knowledge score		Inadequate	68	90	.67 (.44, 1.04)	.073	
		Adequate	65	128	1	1	

Key: **: means significant at p-value <0.05; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval. Those with p value 0.2 and less than were entered into the multivariate regression model.*

6.4.3 Factors associated with practice scores of study participants

Associated factors among cleaners were measured with Chi square or Fisher exact tests as appropriate since their numbers were small for regression analysis. Hence only presence of significant association among predictor variables was assessed. Accordingly, working hours per day (p= 0.014) and attitude scores (p=0.034) significantly associated with cleaners practice score. Whereas HCPs number was large enough for bivariate and multivariate logistic analysis to assess the strength of association. In the bivariate analysis, sex, information source of BMW from friends, other information sources, type of health facility, and job category were marginal and working in OPD, information source of BMW from training, educational level, knoweledge score, use of visual aid, presence of designated

individual/ BMWM committee in the facility, availability of guideline/operational document, previous training access, and availability of all the thee color coded bins in the department/section were showed significant association. After adjustment of possible confounders, availability of visual aid/instruction was 4.55 times more likely contribute for adequate BMWM practice given that other predictor variables were holding constant. Availability of all three types of color coded bins in the department/ working section was 6.27 times more likely to contribute for adequate BMWM practice and BSc holders were 0.27 times less likely to have adequate practice score of BMWM compared to diploma holders given that other variables were holding constant. Other predictor variables did not show any significant association in the multi variable regression analysis [Table 7].

Table 7. Bivariate and multivariate logistic regression of factors associated with practice scores of study participants at Debre Markos town HCFs, Northwest Ethiopia, 2017 (n=296).

Variables			Practice		COR(95%CI)	P-value	AOR (95%CI)
			Inadequate (n)	Adequate (n)			
Sex		Male	45	132	.67 (.38, 1.18)	.164	
		Female	22	97	1	1	
OPD department		Yes	33	71	.46 (.27, .81)	.007	
		No	34	158	1	1	
Information source	Training	Yes	24	118	1.91 (1.09, 3.34)	.025	
		No	43	111	1	1	
	Friend	Yes	14	76	1.88 (.98, 3.60)	.057	
		No	53	153	1	1	
	Other	Yes	20	45	.58 (.31, 1.07)	.078	
		No	47	184	1	1	
Educational level		≥MSc	5	15	.35 (.11, 1.14)	.081	
		BSc	51	119	0.27 (.13, .55)	.001	.27 (.11, .66)*
		Diploma	11	95	1	1	1
Type of facility		Hospital	51	146	.44 (.15, 1.32)	.144	
		Health center	12	57	.73 (.22, 2.48)	.615	
		Clinic	4	26	1	1	
Job category		Doctor	13	18	.42 (.13, 1.32)	.137	
		Nurse	37	126	1.02 (.38, 2.73)	.966	
		Midwife	2	25	3.75 (.68, 20.63)	.129	
		Lab	9	40	1.33 (.42, 4.27)	.628	
		HO	6	20	1	1	
Knowledge score		Inadequate	38	90	.49 (.29, .86)	.012	
		Adequate	29	139	1	1	
Previous training		Yes	17	92	1.98 (1.07, 3.64)	.029	
		No	50	137	1	1	
Availability of visual aid near the waste receptacles in the department (n=296)		Yes	19	155	5.29 (2.91, 9.63)	0.001	4.55 (2.21, 9.37)*
		No	48	74	1	1	1
Availability of designated individual/ BMWM committee		Yes	30	158	2.75 (1.57, 4.79)	.001	
		No	37	71	1	1	
Availability of guideline or operational document		Yes	21	138	3.30 (1.86, 5.93)	.001	
		No	46	91	1	1	
Availability of all 3 bins		Yes	36	205	7.4 (3.88, 13.95)	.001	6.27(2.69, 14.59)*
		No	31	24	1	1	1

Key: **: means significant at p-value <0.05; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval. Those with p value 0.2 and less than were entered into the multivariate regression model.*

7. Discussion

Biomedical waste management has emerged as a major cause of concern for hospitals, primary health-care centers and environment [44, 45]. It requires removal of wastes from HCFs in such a way that could not be a source of hazard. Health care workers are key for effective management of BMWs generated from the HCFs [46]. The problem could be aggravated by absence of appropriate PPEs, inadequate training, lack of accessible guideline/ operational document related to waste management/ infection prevention, waste collection bins and transporting equipment. Among HCWs, cleaners are mainly exposed for BMW related hazards and need appropriate PPEs. In this study, all cleaners were not supplied with boot. This may be due to lack of attention and follow-up by the concerned body. According to the national guideline as a minimum option HCFs are required to segregate BMWs using three types of bins (black, yellow and safety box) [11]. However, in this study only 81.4% HCPs had access to the aforementioned devices at their HCFs. This may be due to weak or absence of designated individual (focal person) or infection prevention committee in the facilities or economic issues as we are economically developing country.

It is obvious that WHO has prepared a guideline to ensure safe management of wastes from health care activities [2]. In addition, in this country there are three health care waste management guidelines prepared by federal ministry of health [11], federal environmental protection authority [43], and Ethiopian Food, Medicine and Healthcare Administration and Control Authority [10]. However, in this study more than half (54%) of HCPs did not access any of these or other similar guidelines/ operational documents related to waste management or infection at their department. This result was better than studies conducted at West Gojjam health centres where the guideline document was not available in any of the surveyed health centers and Gondar town (96.9%) [21, 30]. The possible explanation for this difference might be due to study time period difference which might be related to the increased attention given for infection prevention. Method of obtaining data might also be another reason because in this study any written document related to waste management or infection prevention were considered assuming they have an impact on waste management. However, similar study was found in Nigeria where 52.4% study participants did not access guidelines [36].

Hospitals and other HCFs have a responsibility to care for the environment and public health. Thus, training their HCWs for effective BMWM is a very critical step. However, in this study, only 36.8% of study participants were involved in BMWM or related trainings which is lower than 61.6%, 44.3% and 46.9% studies conducted in Bangladesh, India and Gondar town respectively [35, 47, 48]. It was similar with 31% from a study conducted in Adama, Ethiopia [17]. More specifically, HCWs' training

access among health centers (24.6%) in this study was higher than a study conducted in West Gojjam health centers where only 10% of HCPs had on job training [21].

According to the national guideline all cleaners (waste handlers) should receive training on BMWM [11]. However, in this study only 30.9% of cleaners had taken training which is lower than 44% and 54.4% reported by studies from southern and eastern Ethiopia, respectively [49, 50]. Probably the difference might be due to lack of attention for them on their role in infection prevention by HCFs' focal person/infection prevention committee. Regarding incidence of needle stick/sharp injuries, about 24.5% cases occurred during the previous 12 months proceeding the data collection time. This result was better than 51% and 30.8% from Nigeria and Gondar town [51, 52]. However similar result (25%) was found at Gondar town with different time period [48]. Specifically, prevalence of needle stick/sharp injuries among health centers (14%) was almost comparable with a study conducted in west Gojjam health centers (12.5%) [21].

According to guidelines as a minimum approach to prevent occupational health risks, it is highly recommended for workers to be protected by HBV vaccination [2, 10]. However, in this study HBV vaccination was found to be low (29%) as the level of occupational exposure is high among the study participants. It was extremely low compared to 85.8% and 95% studies conducted in India and Iran respectively [46, 34]. Unavailability and cost of the vaccine might be the possible cause for low vaccination status in the studied HCFs. This result was however better than 10% a study conducted at Bahir Dar [53] and more or less comparable with a study conducted at Addis Ababa city governmental hospitals 24.6% [54].

7.1 Knowledge of study participants

In this study the overall adequate knowledge score was 55%. If we separately analyse frequency of adequate knowledge score was higher among medical labs (71%), health officers (69%) followed by doctors 61.3% and the list adequate knowledge score was among cleaners (45%). This result was better than a study conducted in Nigeria where only 45% study participants were had good knowledge [36] however, it was more or less comparable with 59.5% a study conducted in Sri Lanka [55]. This study was inconsistent with a study conducted in Tripura where highest good knowledge scores was among nurses (87%) and the list was among sanitary staff (27%) [44]. This difference might be due difference in academic knowledge or availability and strength of BMWM/infection prevention committee. Better result was found in Bangladesh where about 67% doctors and 66% nurses had adequate knowledge score however the current study was better in case for laboratory professionals' adequate knowledge score (39%) [56]. Similarly, a study conducted in Egypt stated a higher satisfactory knowledge score among doctors (68.3%) and nurses (60.9%) [39], Moreover a study

conducted in India showed that knowledge score as satisfactory was highest among doctors (86%), followed by nurses (70%) and the list was among labs (46%) [31]. these gaps might be due to training access, national health sector strategy or academic knowledge difference. However, the current study was better than a study conducted India where only 52.7% physicians and 45% lab technicians had satisfactory knowledge score [57]. In this study, cleaners' adequate knowledge score (45%) was more or less comparable with a study conducted in Egypt (44.4%) [39]. However, it was higher than 24% and 36.07% studies conducted in Bangladesh and India respectively [56, 57]. More specifically about 84.8% HCPs had awareness on whether their HCF generate BMWs which is more or less comparable with the study conducted in India where about 89.5% HCWs had awareness that their HCF generate BMWs [46]. However, this result was better than a study conducted in Iran in which only 47% of HCWs considered hospitals as the producer of medical waste [34]. In the current study awareness about hazards associated with BMW is highest among doctors (96.8%) which is confirmed with a study conducted in India where awareness on hazards associated with BMWs was highest among doctors (84.2%) [46].

At a national level a three-bin system waste segregation has been established as a minimum standard using three types of waste containers (black, yellow and safety box for general, hazardous and sharp wastes respectively) [10, 11]. Nevertheless; in this study only 77.2% of the study participants had knowledge of color coding segregation which is lower than the 92.3% report from India [44]. Specifically, 72.6%, 78.3% and 86.3% study participants were able to identify that general, infectious and sharp wastes should be placed into the black, yellow and safety box respectively. This gap might be due to lack of standard color coded three bins for waste segregation in the studied HCFs, lack of strict follow-up from the concerned body or might be due to lack of training on how to separate BMWs.

Awareness on segregation of infectious wastes was better than a study conducted in Iran in which only 48.2% HCWs had knowledge of items to be disposed in yellow bag [34]. Only 70% of study participants had awareness about final BMW disposal methods which is more or less comparable with the study conducted in India (74.8%) [44]. According to guidelines infectious waste containers should be labelled with the universally accepted symbol of biohazard [2, 10, 11, 43]. Slightly over half (53.6%) of study participants were able to identify the biohazard symbol which is similar with a study in India (54.4%) [32]. However, a better result was found in Nanital where majority of HCWs (85.5%) were able to identify symbol of biohazards [13].

According to guidelines, infectious wastes should be stored a maximum of 48 hours (two days) [2, 10, 11, 43]. However, in the current study only 10% of HCWs had awareness that infectious waste could

be stored a maximum of 48 hours before being treated or disposed of. This finding is lower than a study conducted in India where about 36.5% HCWs were not able to identify maximum time limit of BMWs to be stored before treatment or disposal [32]. This gap might be due to lack of specific training.

7.2 Attitude of study participants

The overall composite positive attitude score among HCWs in this study is 62.1 which is more or less comparable with 59.9% a study conducted at Gondar town, Ethiopia [30]. Another recent finding in Tripura, India indicated that almost all studied participants had good attitude regarding BMWM [44]. On the other hand, a study conducted in Nigeria showed a lower finding in which only 45.5% of HCWs had positive attitude [36]. This difference might be due to study participant perception difference on the impact of BMWs, lack of accessible guideline or other waste management documents which might have an important implication on the individuals' perception. It could be methodological variability as they have used small number of study participants. More specifically in this study about 92%, 91.7% and 76.9% HCWs agreed that HIV, HBV and HCV respectively could have transmitted through BMWs. A study conducted at Gondar town revealed a better attitude on transmission of HIV through BMWs (97.7%). This result is better than 84.6% and 76.9% for HBV and HCV transmission respectively [30]. This difference might be due to education background, training, and commitment of healthcare staffs.

In the current study about 70.7% of HCWs agreed that BMWM add extra burden of work. However, studies conducted in India at different time and places indicated lower results in which about 23.5% and 56.8% study participants perceived that safe management of health care waste is an extra burden of work [32, 46]. This difference might be due to cultural background difference, motivation from infection prevention authorities, academic knowledge deference or governmental attention for infection prevention. In the current study about 89.2% of study participants perceived safe BMWM as an issue involving a teamwork which was better than a study conducted in India where only 25.1% study participants perceived health care waste as an issue [32]. A slightly better result was found with the most recent study conducted in India (94.8) at a different place [44]. This difference might be due to difference on educational level as they included about 82% post graduate HCWs, commitment of study participants or government attention difference on infection prevention or waste management. With regard to waste segregation and treatment, about 86.3% and 74.6% study participants agreed about BMW segregation at source and disinfection before disposal respectively. Nearly similar study was found in India regarding waste segregation at source (88.1%). Nonetheless, attitude on BMW treatment before disposal was better than the current study (88.7) [44]. This difference might be due to

less attention given in the current study for waste disposal and impacts of BMW on community health in general.

7.3 Practice of study participants

The overall practice score of study participants was 78.9% which is better than 31.5 % a study conducted at Gondar town Ethiopia [48]. This difference could be due to waste segregation bin supply difference, staff commitment on infection prevention/waste management, motivation and enforcement from concerned bodies, workload or lack of work experience, job satisfaction and other factors might be important factors to bring practice of biomedical waste management. In this study, the highest practice score was among midwifes (92.6%) followed by cleaners (87.3%) and the list practice score was disappointingly among medical doctors (58.1%). One could ask if over qualification leads to ignorance. However, this result was better than a study conducted in Bangladesh where about 56% medical doctors and 44.0% cleaning staff had good practice regarding medical waste management [56]. This difference could be due to lack of training, staff commitment, motivation and enforcement from concerned bodies, ignorance, job dissatisfaction, lack of waste management equipment. Similarly, a study conducted in India indicated that the highest practice score was among Nurses (97.3%) followed by doctors (77.8) and the list was among sweepers [33]. A better result was found in Egypt where about 84% nurses and 67.3% physicians had satisfactory practice scores [39]. This difference could be due to educational background difference, accessibility of waste management equipment, training access and type of training, work experience, work load, motivation and enforcement by concerned bodies or might be due to work load difference. Similarly, a study conducted in Agartala, India revealed about 88.7% nurses, 80.2% doctors had good practices score followed by lab technician (70%) which is lower than the current study except labs [44].

Probably this difference might be due to accessibility of BMWM equipment as most of (89.7%) study participants in their study used color coded bins, accessibility and use guideline/other related documents or study participants' commitment for waste management and other possible factors. With regard to glove usage, about 78.9% HCPs were always used while handling/working with BMWs which is higher than a study conducted in Nigeria (69.2%) [37]. Probably this difference might be due to perception difference of study participants or lack of glove.

Biomedical waste segregation is the most important step for proper waste management as it reduces the amount of infectious waste generated, waste treatment cost and risks associated with mismanagement of wastes. It should be done at the point of waste generation using different colour coded waste bins [2]. However, in this study 88.2% of HCPs followed color coding segregation which is better than 80.6% and 21.7% in studies conducted in Agartala, India and Nigeria respectively [44,

58]. Probably this difference might be due to lack of training, waste management equipment, strict follow-up and motivation or it might be due to workload, work experience, individual commitment for waste management/ infection prevention. Specifically, about 83.9%, 85.9%, 100% and 91.8% midwife, labs, nurse and doctors respectively have reported that they followed color coding segregation. More or less this result did not meet national guideline requirements that all hazardous should be segregated at the point of generation [2, 10, 11, 43]. In addition, if there is even a very small amount of miss segregated infectious waste, it can contaminate the entire mass (general waste) and the whole become infectious waste which can cause hazard on those who manipulate wastes later on. More specifically about 83.4% HCPs were always segregated sharps into the safety box which is slightly higher than a study conducted in Nigeria where about 71.9% HCWs were always segregate sharps into the safety box [37].

The most effective PPE in reducing risk of injury for medical staff are gloves to protect them from exposure of blood and other potentially infectious materials. They are obligatory and must be always used while handling or working with BMWs [2]. In this study 94% HCPs always used gloves indicating HCPs still handle BMWs without gloves. Probably this gap might be due to lack of sufficient glove access in their HCFs or it might be due to ignorance or negligence of hazards associated with mismanagement of wastes. Similarly, heavy duty glove and boots are used to protect cleaners from sharp injuries and aprons from splash of liquid infectious substances [2]. Only 80% and 72.7% cleaners in our study reported that they have always used heavy-duty gloves and apron respectively. However, observationalusing checklist reealed a better result in which about 83.7% and 87.3% cleaners used heavy-duty glove and apron respectively. However, in both cases, none of the cleaners were used boot and sometimes they were observed wearing sandals and using latex glove which are strictly prohibited activity for cleaners. Nevertheless; PPE usage among cleaners was below the national guideline requirements [11]. This gap might be due to lack of appropriate PPE supply or lack of awareness as they were educationally low level. Cleaners disclosed lack of PPEs in the facilities.

According to guidelines BMWs should not be stayed more than 24 hours in the health care delivery rooms [2, 10, 11, 43]. In both interview and observation results cleaners collected wastes from service area within the prescribed time schedule (24 hours) which was a much appreciated activity. Similarly, according to guidelines BMWs should be transported separately as they were segregated with closed containers [2, 10, 11]. However, only 85.5% and 58.2% of cleaners separately transport BMWs as they were initially segregated and closed waste containers during transport respectively. This gap might be due to lack of appropriate waste transporting equipment, lack of awareness on importance of waste

segrigat5tion or work overload. According to guidelines wastes may be transported using trolley, wheel barrow or buckets. In this study most hospital cleaners were mainly used trolleys as transporting means while others were mainly using open buckets which is not recommended [2, 10, 11].

7.4 Treatment and disposal

In most of the studied HCFs (92.8%) there was no central waste storage room (facility) rather they used puncture resistant containers (bins) to store until treatment. Most of them were stationed inside the door where they were originally generated. One HCF used incinerator chamber as a temporary waste storage means. Both practices were not in line with national guideline requirement where in all HCFs separate central storage facilities shall be provided for hazardous HCWs [11]. Also according to this guideline infectious waste should not be stored more than two days (48 hours). In most HCFs, however, treatment was done according volume of waste collected rather than pre-established maximum time limit and this activity is also contradictory to the guideline [11]. Especially most non-governmental HCFs did this kind of activity. Two HCFs were burning all types of BMW in unprotected open ground or pit burning. Under no exceptional circumstances these types of mal practices were strongly prohibited as they are endangering the community. In addition to this drum incinerator are recommended outside the urban area where there is no any other option for treatment [43].

Three HCFs in the current study were used in the town with this type of waste treatment technology. About 4(28.5%) HCFs did not fence their burning area/incinerator and they were easily accessible. This practice was against the guideline that all incinerators /burning areas must be fenced to prevent access by the community or animals [10, 11]. Most HCFs (93%) did not have specifically designed ash pit and they dispose into either placenta pit, latrine opening or open dumping near the incinerator area. These activist are strongly prohibited and are out of the guidelines recommendation [10, 11].

7.5 Associated predictor variables with KAP of study participants:

In this study, being in 26-30 years age group was 3.2 times more likely to contribute for adequate knowledge score than greater than 30 years age group. Probably this may be due to 26-30 years age group might be active learners compared to 30 years and above age groups. Working in wards was also 2.81 times more likely to contribute for adequate knowledge score than not working in ward. Probably this may be due to the fact that those HCWs who were working in ward might follow patients and take more time with their clinical practice compared to other HCWs who were not working in ward and they might have get knowledge from their practice. According to national guideline, all HCWs who handle infectious waste should receive infectious waste management training at least once a year [11].

When they practice color coding segregation, they might get knowledge about BMWM and this knowledge intern could bring attitudinal change of HCWs.

This might be due to information from guideline might bring knowledge change and this knowledge change might in turn bring attitudinal change. Similarly, 8 hours and greater than 8 hours working per day was 7 and 6.6 time more likely to contribute for positive attitude, respectively compared to less than 8 working hours per day. If they work more time, their practice might be developed and bring attitudinal change. Being a hospital worker was 2.87 times more likely to have positive attitude compared to clinic workers.

On the other hand, BSc holders were 66% less likely to practice BMWM compared to those diploma holders. Availability of all three bins in the department was 6.27 times more likely to contribute for adequate practice compared to absence of these bins. This finding could be explained by the fact that, appropriate BMW segregation need standard color coded bins. A study conducted at Gondar university hospital confirm this result in which respondents who had no color coded containers in the working department were 82% less likely to correctly practice waste segregation than who do have color coded container in the working department [59]. Working hours per day and attitude scores were significantly associated with cleaners practice at p-value of 0.014 and 0.034, respectively.

8. Strength and limitation of the study

8.1 Strengths of the study

- Health facilities and study participants were selected from different dimension, (from public, private and NGOs) in order to make the study more representative.
- Use of multiple data collection methods (questionnaire and observation check lists), which is important to triangulate the finding of this study.
- Including cleaners in the study was the main strength in which none of the studies conducted in Ethiopia so far included them

8.2 Limitations of the study

I. Due to the nature of the study design there may be information bias, which may create different findings between questionnaire and observation checklist.

9. Conclusion and recommendation

9.1 Conclusion

In this study, the overall adequate knowledge, positive attitude and adequate practice scores were 193(55%), 218(62.1%) and 277(78.9%) respectively. Cleaners were the list regarding adequate knowledge and positive attitude score while the list practice score was noted among medical doctors. In general, in this study levels of KAP scores were low and majority of HCPs and cleaners were not vaccinated against HBV. Even though it is not comparable, HCPs were having better knowledge and attitude than cleaners whereas; cleaners had relatively better practice than HCPs. Regarding associated factors with KAP of study participants, there was statistically significant association between KAP towards BMWM with age, working in wards, longer working time, and educational level with BSc and above.

9.2 Recommendation

- BMWM trainings should be given with special emphasis for cleaners
- HCFs should supply PPE, color coded bins and transporting equipment in the HCFs
- Regional, zonal and district health offices should act according to their responsibilities towards better BMWM
- Awareness should be created on HCWs about BMW hazards
- BMWM guidelines or other related documents should be put in work place
- Experts who want to study BMW should give prior attention for its management
- District health office should facilitate to establish common BMW treatment plant

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For Health Care Professionals

Health Care Facility Identification Code ____

Study Participant Identification Code _____

11. Annex

Annex I: English version questionnaires and observational check lists

1. Information sheet:

Title of the research: Assessment of Knowledge, Attitude, and Practice about Bio-Medical Waste Management and Associated Factors among Health Care Workers at Debre Markos Town Health Care Facilities, Northwest Ethiopia

Principal investigator: Teshiwal Deress

I am Teshiwal Deress a post graduate student in Clinical Laboratory Quality Assurance and Management at Addis Ababa University. The approval to carry out this study was given by ethical review committee of department of medical laboratory sciences, Addis Ababa University.

Objective: The objective of this study is to assess knowledge, attitude and practice about biomedical waste management and associated factors among health care workers at Debre Markos town health care facilities.

Perceived benefits and risk: The result may benefit clients, health care worker, health care facility managers, researchers, policy makers and other stakeholders as apropriate. Being involved in this study does not induce any risk you will face.

Confidentiality: All personal identifiers and personal information will not be taken hence your responses will be kept confidential. Data will be accessed by the principal investigator, advisors and research assistant only and finally will be analyzed anonimesly.

Participation and withdrawal: Your participation in this study which will take you about 8 minute is fully voluntarily. You will be free to withdraw from the study at any time or not to answer questions if you don't want to answer.

Coordinating organization: Addis Ababa University, College of Health Sciences, Department of Medical Laboratory Sciences

Persons to contact: If you have questions/ concerns about this study you can contact;

Principal investigator: Mr**.** Teshiwal Deress (Mob: +251921638642, Email: teshiwalderes@gmail.com)

Advisors: Dr. Aster Tsegaye (Email: tsegayeaster@yahoo.com)

Mrs. Fatuma Hassen (Email**:** fatumahassen2000@yahoo.com)

2. Consent form:

Dear participant! You are among the study participants selected from the health care workers in the facility. It is your full right to participate in this study but if you are not willing to take part you can leave the questionnaire empty however; your honest answers to these questions will help me to get important data on biomedical waste management and associated factors, so; you are kindly requested to give your honest responses and keep participation. It will take a maximum of 8 minutes to answer these questions. Would you willing to participate please? If your answer is yes encircle 1 and go to the next part.

1. Yes 2. No

Dear participant! For the sake of confidentiality please do not write your name or other personal identifier on the questionnaire!

3. Questionnaire and observational checklist for HCPs

Please read the instruction and questions for each section before you answer, if you have unclear question or instruction you can ask the principal investigator or assistant.

Section 1: Socio-demographic and health care related profile

Please encircle your choice code among the given alternatives.

No.	Socio Demographic Variables	Answer
101.	Sex?	1. Male 2. Female
102.	Age in full years?	_____years
103.	What is your level of education?	1. MSc and above 2. First Degree 3. Diploma
104.	In which health care facility are you working now?	1. Hospital 2. Health center 3. Clinic
105.	What is your job category?	1. Medical doctor 2. Nurse 3. Midwifery 4. Medical laboratory 5. Health officer
106.	In which department/ section are you working now? **(More than one**	1. OPD 2. Ward

	answers are possible)	3. Laboratory room 4. Emergency room 5. Others (specify) _____
107.	How much is your work experience as a health care professional?	_____Years
108.	How much is your working hours per day on your profession?	_____Hours/day
109.	Where do you get information about biomedical waste management? **(More than one answers are possible)**	1. Guide line 2. Training 3. Friends 4. Others (specify)_____
110.	Have you ever taken training on biomedical waste management or related issues?	1. Yes 2. No
111.	Have you taken vaccine for hepatitis B virus?	1. Yes 2. No
112.	Is there any guideline /operational document for biomedical waste management or infection prevention in your department/ section?	1. Yes 2. No 3. Not sure
113.	Is there designated individual/ biomedical waste management committee in the facility?	1. Yes 2. No 3. Not sure

<u>Section 2:</u> Questions to assess knowledge of health care professionals about biomedical waste management and associated factors at Debre Markos town health care facilities.

Please encircle your choice code among the possible alternatives for the questions given below in the table.

No.	**Questions to assess health care professionals' knowledge**	**Answer**		
		Yes	**No**	**Not Sure**
201.	Does your facility generate biomedical wastes?	1	2	3
202.	Do you now about biomedical waste management?	1	2	3
203.	Is there any health hazard associated with biomedical wastes?	1	2	3
204.	Is needle-stick or sharp injury a concern?	1	2	3
205.	Does wearing personal protective equipment reduce risk of infection?	1	2	3
206.	Are all biomedical wastes biologically hazardous (infectious)?	1	2	3

207.	Are items contaminated with body fluids considered as biomedical wastes?	1	2	3
208.	Do you know about color coding segregation of biomedical wastes?	1	2	3
209.	Should infectious waste containers be labelled with biohazard symbol?	1	2	3
210.	Should biomedical wastes be segregated into different categories at the point of generation?	1	2	3
211.	Does disinfection of infectious biomedical wastes decrease infection transmission?	1	2	3
212.	Do we need to close biomedical waste containers while transport?	1	2	3
213.	Do we need to secure stored biomedical wastes awaiting for treatment and disposal?	1	2	3
214.	Do you know about biomedical waste disposal methods?	1	2	3

215. What is the maximum time of infectious biomedical wastes can be stored before treatment or disposal?

1. 24 hours
2. 48 hours
3. 72 hours
4. I don't know

216. Which of the following is internationally accepted symbol for biohazard?

1. 
2. 
3. 
4. 

217. What type of biomedical waste should be disposed in a yellow biomedical waste disposal bin?

1. General waste
2. Infectious waste
3. I don't know

218. What type of biomedical waste should be disposed in a black biomedical waste disposal bin?

1. General waste
2. Infectious waste
3. I don't know

219. Where should medical supplies capable of causing puncture or cut be disposed?

1. Black bin
2. Yellow bin
3. Safety box
4. I don't know

220. How maximum full should be the safety box containing sharp medical supplies?

1. ½ full
2. 3/4 full
3. Full
4. I don't know

221. According to World Health Organization guideline, what is the maximum delay to start HIV post-exposure prophylaxis?

1. 24 hours
2. 48 hours
3. 72 hours
4. I don't know

Section 3: Questions to assess attitudes of health care professionals' attitude about biomedical waste management at Debre Markos town health care facilities.

Based on the following scale of measurement 1-5 ((1=Strongly Disagree (SD); 2=Disagree (D); 3= Neutral (N); 4= Agree (A) and 5=Strongly Agree (SA)); please read each statement and select your answer from the right margin of the table that you believe.

No.	What is your opinion/belief on the following statements?	SD	D	N	A	SA
301.	Improperly managed health care wastes may cause infection	1	2	3	4	5
302.	Proper biomedical waste handling is an issue and a matter of concern	1	2	3	4	5
303.	Safe biomedical waste management is an issue involving a team work	1	2	3	4	5
304.	HIV may be transmitted through biomedical wastes	1	2	3	4	5
305.	HIV post exposure prophylaxis will help to prevent development of HIV infection	1	2	3	4	5
306.	Hepatitis B virus may be transmitted through biomedical wastes	1	2	3	4	5
307.	Hepatitis C virus may be transmitted through biomedical wastes	1	2	3	4	5
308.	Biomedical wastes do not transmit any infectious diseases	1	2	3	4	5
309.	Biomedical wastes should be segregate into different categories at the point of generation	1	2	3	4	5
310.	Biomedical waste segregation facilitate safe handling of the waste	1	2	3	4	5
311.	Labeling of biomedical waste containers does not add value on biomedical waste management	1	2	3	4	5
312.	Proper biomedical waste disposal is important to prevent infection transmission	1	2	3	4	5
313.	Biomedical waste disinfection can reduce the chance of contracting infection	1	2	3	4	5
314.	Wearing personal protective equipment helps to reduce risk of infection	1	2	3	4	5
315.	Biomedical waste management add extra burden of work	1	2	3	4	5
316.	Bio hazardous wastes should be disinfected before disposal	1	2	3	4	5

Section 4: Questions to assess practices of health care professionals about BMW management at Debre Markos town health care facilities. Please encircle your choice among the possible alternatives given the table below. Please use the following description for the terms given in the question.

Keys: For question 303 sufficient means availability of enough glove for 1-day consumption and for question 404 and 405 always means use of the indicated personal protective equipment continuously while it is necessary, sometimes means when you use occasionally while it is necessary and never means when you don't use the indicated personal protective equipment at all times while it is necessary.

No.	Variables	Response		Remark
401.	Have you ever encountered any sharp /needle stick injury in the last 12 months?	1. Yes	2. No	
402.	Is there visual aid/ instruction present near the waste receptacles?	1. Yes	2. No	
403.	Are gloves available in sufficient quantity in your facility?	1. Yes	2. No	
404.	How often do you use gloves while you are working with/handling of biomedical wastes?	1. Always 2. Sometimes 3. Never		
405.	How often do you wear gown while you are working with/handling of biomedical wastes?	1. Always 2. Sometimes 3. Never		
406.	Do you label biomedical waste containers?	1. Yes	2. No	
407.	Are all 3 bins (black bin, yellow bin and safety box) available in your department/ section?	1. Yes	2. No	
408.	Do you segregate biomedical wastes according to their type at the point of generation?	1. Yes	2. No	
409.	If yes on question 408, do you follow color coding segregation?	1. Yes	2. No	If **No** stop

410. Where do you put non-infectious wastes like paper, plastic and other supplies?

1. Black waste bin
2. Yellow waste bin
3. Other (specify)_____

411. Where do you put infectious wastes like cotton, gauze and other items contaminated with blood and body fluids?

1. Black waste bin
2. Yellow waste bin
3. Other (specify)_____

412. Where do you put sharp waste medical supplies which may cause punctures or cuts?

1. Safety box
2. Black plastic bin
3. Yellow plastic bin
4. Other (specify)___

Dear Participant Thank You for Your Cooperation

For health care professionals

Health Care Facility Identification Code ____

Study Participant Identification Code _____

<u>Section 5:</u> Health care professionals' practice observation checklist

Data collector should observe actual practices of health care professionals and tick the appropriate alternative code in the table given below

No.	Activities to be observed	Answer		Remark
		Yes	No	
501.	Is there visual aid/ instruction present near the waste receptacles?	1	2	
502.	Are gloves available in sufficient quantity?	1	2	
503.	Does he/she use gloves while handling/ working with biomedical wastes?	1	2	
504.	Does he/she wear gown while handling/ working with biomedical wastes?	1	2	
505.	Is there yellow bio-hazardous waste disposal bin in the section?	1	2	**If No go to 508**
506.	If yes does it contain only infectious waste?	1	2	
507.	Is there black biomedical waste disposal bin in the section?	1	2	**If No go to 510**
508.	If yes does it contain only non-infectious waste?	1	2	
509.	Is there a biohazard symbol labelled safety box in the section?	1	2	
510.	Does he/she segregate biomedical wastes according to their category?	1	2	
511.	Are all available bins clearly labelled?	1	2	
512.	Is there infectious waste container more than 3/4 full?	1	2	

Appointment 1: Time _____Date _____ Appointment 2: Time _____Date _____

For cleaners

Health Care Facility Identification Code _____

Study Participant Identification Code _____

1. Information sheet

Title of the research: Assessment of Knowledge, Attitude, and Practice of Bio-Medical Waste Management and Associated Factors among Health Care Workers at Debre Markos Town Health care facilities, Northwest Ethiopia

Principal investigator: Teshiwal Deress

I am Teshiwal Deress a post graduate student in Clinical Laboratory Quality Assurance and Management at Addis Ababa University. The approval to carry out this study was given by ethical review committee of department of medical laboratory sciences, Addis Ababa University.

Objective: To assess knowledge, attitude and practice of biomedical waste management and associated factors among health care workers at Debre Markos town health care facilities.

Perceived benefits and risk: The result may benefit clients, health care worker, health care facility managers, researchers, policy makers and other stakeholders as apropriate. Being involved in this study does not induce any risk you will face.

Confidentiality: All personal identifiers and personal information will not be taken hence your responses will be kept confidential. Data will be accessed by the principal investigator, advisors and research assistant only and finally will be analyzed anonimesly.

Participation and withdrawal: Your participation in this study which will take you about 10 minute is fully voluntarily. You will be free to withdraw from the study at any time or not to answer questions if you don't want to answer.

Coordinating organization: Addis Ababa University, College of Health Sciences, Department of Medical Laboratory Sciences

Persons to contact: If you have questions/ concerns about this study you can contact;

Principal investigator: Mr. Teshiwal Deress (Mob: +251921638642, Email: teshiwalderes@gmail.com

Advisors: Dr. Aster Tsegaye (Email: tsegayeaster@yahoo.com)

Mrs. Fatuma Hassen (Email**:** fatumahassen2000@yahoo.com)

2. Consent form

Dear participant! You are among the study participants selected from the health care facility. It is your full right to participate in this study however; your honest answer to these questions will help me to get important data on knowledge, attitude and practice of biomedical waste management and associated factors, so, you are kindly requested to give your honest responses and keep participation. It will take a maximum of 10 minutes to answer questions. Would you be willing to participate please?

1. Yes 2. No

Dear interviewer! For the sake of confidentiality please do not write participants name or other personal identifier on the questionnaire!

3. Questionnaire

For interviewer: *If the participant agree to take part in the study; please read each instruction and question for her/him until she/he understand it. If there is unclear instruction or question, please elaborate it more without losing its concept.*

Section 1: Socio-demographic and health care facility related profile

Please tell me your answer from the following questions and alternative options I read.

No.	Socio Demographic Variables	Answer
101.	Sex?	1. Male 2. Female
102.	Age in full years?	_____ years
103.	What is your level of education?	1. Diploma 2. Certificate 3. Secondary 4. Below primary
104.	In which health care facility are you working now?	1. Hospital 2. Health center 3. Clinic
105.		_____
106.	In which department/ section are you working now? **(More than one answers are possible)**	1. OPD 2. Ward 3. Laboratory room 4. Emergency room 5. Others (specify) _____
107.	How much is your work experience as a health care facility cleaner?	_____Years

108.	How much is your working hours per day as a cleaner at health care facility?	_____Hours/day
109.	Where do you get information about biomedical waste management? **(More than one answers are possible)**	1. Guide line 2. Training 3. Friend 4. Others (specify)_____
110.	Have you ever taken training on biomedical waste management or related issues?	3. Yes 4. No
111.	Have you taken vaccine for hepatitis B virus?	1. Yes 2. No
112.	_____	
113.	_____	

Section 2: Questions to assess knowledge of cleaners about biomedical waste management at Debre Markos town health care facilities.

For the Interviewer: *Please read each question and alternative options to the cleaner clearly and encircle the answer from the right margin of the table.*

No.	Questions to assess cleanerss' knowledge	Answer		
		Yes	No	Not sure
201.	Does your facility generate biomedical wastes?	1	2	3
202.	Do you now about biomedical waste management?	1	2	3
203.	Is there any health hazard associated with biomedical wastes?	1	2	3
204.	Is needle-stick or sharp injury a concern?	1	2	3
205.	Does wearing personal protective equipment reduce risk of infection?	1	2	3
206.	Are all biomedical wastes biologically hazardous (infectious)?	1	2	3
207.	Are items contaminated with body fluids considered as biomedical wastes?	1	2	3
208.	Do you know about color coding segregation of biomedical wastes?	1	2	3
209.	Do infectious waste containers be labelled with biohazard symbol?	1	2	3
210.	Should biomedical wastes be segregated into different categories at the point of generation?	1	2	3
211.	Does disinfection of infectious biomedical wastes decrease infection transmission?	1	2	3
212.	Do we need to close biomedical waste containers while transport?	1	2	3

213.	Do we need to secure stored biomedical wastes awaiting for treatment and disposal?	1	2	3
214.	Do you know about biomedical waste disposal methods?	1	2	3

215. What is the maximum time of infectious biomedical wastes can be stored before being treated or disposed?

1. 24 hours
2. 48 hours
3. 72 hours
4. I don't know

216. Which of the following is internationally accepted symbol for biohazard?

1. 
2. 
3. 
4. 

217. What type of biomedical waste should be disposed in a yellow biomedical waste disposal bag/bin?

1. General waste
2. Infectious waste
3. I don't know

218. What type of biomedical waste should be disposed in a black biomedical waste disposal bag/bin?

1. General waste
2. Infectious waste
3. I don't know

219. Where should medical supplies capable of causing puncture or cut be disposed?

1. Black waste bin
2. Yellow bin
3. Safety box
4. I don't know

220. How maximum full should be a safety box containing clinically used sharp medical supplies?

1. ½ full
2. 3/4 full
3. Full
4. I don't know

221. According to World Health Organization guideline, what is the maximum delay to start HIV post-exposure prophylaxis?

1. 24 hours
2. 48 hours
3. 72 hours
4. I don't know

Section 3: Questions to assess attitude of cleaners on biomedical waste management at Debre Markos town health care facilities.

For the interviewer: *Please first read the following instruction clearly for the cleaner!*

On the following scale of measurement1-5 (1= Strongly Disagree (SD); 2=Disagree (D); 3= Neutral (N); 4= Agree (A) and 5=Strongly Agree (SA)); Please tell me your attitude for biomedical waste management statements given below.

No.	What is your opinion/belief on the following statements?	SD	D	N	A	SA
301.	Improperly managed health care wastes may cause infection	1	2	3	4	5

302.	Proper biomedical waste handling is an issue and a matter of concern	1	2	3	4	5
303.	Safe biomedical waste management is an issue involving responsibilities of each and every health care staff	1	2	3	4	5
304.	HIV may be transmitted through biomedical wastes	1	2	3	4	5
305.	HIV post exposure prophylaxis will help to prevent development of HIV infection	1	2	3	4	5
306.	Hepatitis B virus may be transmitted through biomedical wastes	1	2	3	4	5
307.	Hepatitis C virus may be transmitted through biomedical wastes	1	2	3	4	5
308.	Biomedical wastes do not transmit any infectious diseases	1	2	3	4	5
309.	Biomedical wastes should be segregated into different categories at the point of generation	1	2	3	4	5
310.	Biomedical waste segregation facilitate safe handling of the waste	1	2	3	4	5
311.	Labelling biomedical waste containers does not add value on biomedical waste management	1	2	3	4	5
312.	Proper biomedical waste disposal is important to prevent infection transmission	1	2	3	4	5
313.	Biomedical waste disinfection can reduce the chance of contracting infection	1	2	3	4	5
314.	Wearing personal protective equipment helps to reduce risk of infection	1	2	3	4	5
315.	Biomedical waste management add extra burden of work	1	2	3	4	5
316.	Management of biomedical wastes is only the responsibility of the institution	1	2	3	4	5
317.	Bio hazardous wastes should be disinfected before disposal	1	2	3	4	5

Section 4: Questions to assess practices of cleaners about biomedical waste management at Debre Markos town health care facilities

For Interviewer: *Please read each question and alternatives to the cleaner from the table below and then encircle the answer.*

Keys: For question 402 sufficient means availability of enough PPE at list one item per individual. For question 403, 404 and 405 always means use of the indicated personal protective equipment continuously while it is necessary, sometimes means when you use occasionally while it is necessary and never means when you don't use the indicated personal protective equipment at all times while it is necessary.

No.	Variables	Response
401.	Have you ever encountered any sharp /needle stick injury in the last 12 months?	s

402.	Which personal protective equipment is available in sufficient quantity in your facility? **(More than one answers are possible)**	1. Heavy-duty gloves 2. Boots 3. Apron 4. None is available 5. I am not sure
403.	How often do you use heavy-duty gloves while you clean or dispose biomedical wastes?	1. Always 2. Some times 3. I don't use
404.	How often do you use boots while you clean or dispose biomedical wastes?	1. Always 2. Some times 3. I don't use
405.	How often do you use apron while you clean or dispose biomedical wastes?	1. Always 2. Some times 3. I don't use
406.	Do you disinfect/decontaminate reusable cleaning devices with chlorine solution after each use?	1. Yes 2. No
407.	Do you always collect infectious biomedical wastes from service area within 24 hours?	1. Yes 2. No
408.	Do you always separately transport biomedical wastes according to segregation?	1. Yes 2. No
409.	Do you always close biomedical waste containers during transport?	1. Yes 2. No
410.	What kind of equipment do you use to transport biomedical wastes? **(More than one answers are possible)**	1. Trolley/wheelbarrow 2. Closed bucket 3. Open bucket 4. Other (specify)_____

For cleaners

Health Care Facility Identification Code ____

Study Participant Identification Code _____

Section 5: Ocleaners practice observation checklist

For the data collector: *Please observe the cleaner while she/he is on her/his duty. Read each question and encircle the answer from the right margin of the table*

No.	Variables	Response
501.	Which personal protective equipment is available in your facility? **(More than one answers are possible)**	1. Heavy-duty gloves 2. Boots 3. Apron 4. None is available
502.	Did she/he use heavy-duty gloves?	1. Yes 2. No
503.	Dids she/he use boots?	1. Yes 2. No
504.	Did she/he wear apron?	1. Yes 2. No
505.	Did she/he disinfect/decontaminate reusable cleaning devices after use?	1. Yes 2. No
506.	Did she/he collect infectious biomedical wastes from service area within 24 hours?	1. Yes 2. No
507.	Did she/he transport biomedical wastes separately?	1. Yes 2. No
508.	What biomedical waste transporting equipment she/he use? (More than one answers are possible)	1. Trolley/wheelbarrow 2. Closed bucket 3. Open bucket 4. Other (specify)_____
509.	Did she/he close biomedical waste containers during transport?	1. Yes 2. No

Appointment 1: Time _____Date _____ Appointment 2: Time _____Date _____

Facility Identification Code _____

Health care facility observational check list

101. What BMW storage method the facility used?
    1. Onsite storage room
    2. Puncture resistant storage containers
    3. Other specify

102. Is there infectious waste stored for more than two days?
    1. Yes 2. No

103. Does the facility use onsite BMW treatment methods?
    2. Yes 2. No **If No go to 606**

104. What BMW treatment method the facility used? **(Multiple answers are possible)**
    1. Incineration
    2. Sterilization
    3. Chemical
    4. Burning
    5. Other (specify)_____

105. Is there an incinerator? **If no go to 608**
    1. Yes 2. No

106. Is yes, is it fenced to prevent unauthorized access?
    1. Yes 2. No

107. Dose the facility use onsite BMW disposal methods? **If no stop**
    1. Yes 2. No

108. What type of infectious waste disposal method used? (Multiple answers are possible)
    1. Ash pit
    2. Needle pit
    3. Pit burial
    4. Other (specify)___

12. Declaration

I, the under signed, declare that this MSc thesis is my original work and it has not been presented for a degree in any other University. All sources of materials used for this thesis and institutions who gave support have been duly acknowledged.

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