

## Research Article

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## Laboratory Waste Management in the Context of a Pandemic, The Case of Covid-19, In the Buea Health District (Cameroon)

Despaine Atoh<sup>1</sup>, Danielle Claude Bilanda<sup>2</sup>, Joshua Tambe<sup>1</sup> and Orelie Sylvain Mtopi Bopda<sup>3,4,\*</sup>

<sup>1</sup>Department of Public Health and Hygiene, Faculty of Health Sciences, University of Buea, Cameroon

<sup>2</sup>Department of Animal Biology and Physiology, Faculty of Science, University of Yaoundé I, Cameroon

<sup>3</sup>Department of Animal Biology and Conservation, Faculty of Science, University of Buea, Cameroon

<sup>4</sup>Department of Biomedical Sciences, Faculty of Health Sciences, University of Buea, Cameroon

### ABSTRACT

**Introduction:** Laboratory waste management (LWM) is an important precondition to safeguard the healthcare workers (HCWs), community members and the environment, from contamination with infections. Worldwide, at least 5.2 million people die each year from diseases originating from poorly managed medical waste. Managing the Laboratory waste during pandemics as exemplified by COVID-19 requires critical attention to mitigate the transmission of the pathogenic agent. This study aimed at assessing LWM in the context of COVID-19 pandemic in the Buea Health District.

**Methods:** A prospective study was conducted from March to June 2022. A checklist was used to record observations whilst structured questionnaires were used to get information from HCWs. Descriptive analysis (age, sex, profession category, educational status and work experience) was carried out. Bivariate analyses and multivariable logistic regression were used to identify predictor variables for waste management practices of HCWs. Adjusted Odds Ratio at 95% confidence level was used to measure the strength of association. P-value < 0.05 was considered for statistical significance.

**Results:** The proportion of HCWs who had good level of knowledge, good attitude and precautions in LWM were 48.4%, 84.8% and 65.0% respectively. Medical Laboratory Technicians (60.8%) and age group 18-30 years (64.0%) got training on Laboratory waste management. Segregation and disinfection reduced the spread of the disease (88.4%), and Laboratory technicians with good attitudes (50.4%) significantly took precautions in handling Laboratory waste in government hospitals.

**Conclusion:** Less than half of HCWs had good knowledge on LWM. Hence, in-service training is recommended to improve LWM knowledge and practices.

### \*Corresponding author

Orelie Sylvain Mtopi Bopda, Department of Animal Biology and Conservation, Faculty of Science, University of Buea Cameroon.

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### Introduction

Biomedical waste (from Laboratory) is any waste that is generated during the diagnosis, treatment, or immunization of human beings or animals or from research activities, and contains potentially harmful microorganisms [1,2]. Worldwide, at least 5.2 million people, including 4 million children, die each year from diseases originating from poorly managed biomedical waste [1,3]. The frequent use of medical technologies in hospitals and safety measures to stop the spread of COVID-19 have led to a huge increase in the generation of laboratory waste and this contribute in negatively affecting every part of human lives, including the physical world [4]. Considering the global transmission of COVID-19, excessive biomedical waste has become a new major threat to public health as well as to the environment. Exposure to waste can easily infect waste management (WM) workers; thus, the necessary protective gear must be worn by these workers as well as other front line workers (Laboratory technicians, doctors

and nurses) [1,4,5]. The solid waste (sharps, PPE, and pathological waste) generated by COVID-19 positive patients and the health care workers (HCWs) like doctors and nurses who treat them should be considered infectious waste. The situation necessitates installation of appropriate collection mechanisms for infectious waste, with trained HCWs using special containers (marked, lined, and sharp-safe boxes), and subsequent in situ treatment prior to any movement [1,5]. According to the guidelines provided by the World Health Organization (WHO), healthcare solid waste generated during the COVID-19 pandemic is considered infectious waste and the capacity to manage this waste should be increased [6].

Few studies conducted in Cameroon indicated that lack of training, awareness, staff resistance, managerial poor commitment, lack of adequate resources, negligence, and unfavourable attitudes of the HCWs were the main challenges of Laboratory waste management (LWM) [7, 8]. Therefore, assessing the knowledge, attitudes and precautions taken on LWM and its associated factors among

HCWs is a pivotal element to halting this burden. Accordingly, this study was planned to assess LWM in the context of COVID-19 pandemic among healthcare workers in selected health facilities in the Buea health District. Cameroon was the second Sub-Saharan African country most health-impacted by the Covid-19 outbreak with, as of the 24th of August 2020, 186,243 tests performed in, 10% of the tests positive (n=18,662), and 408 deaths recorded due to COVID-19 [8]. Since March 2020, the Cameroonian government implemented nationwide measures to stop COVID-19 transmission. However, little is known about how well these unprecedented measures were observed as the pandemic evolved [8]. As there had been no research on the HCWs knowledge, attitudes, and practice about LWM (to the best of our knowledge!), we decided to conduct this study during the COVID-19 pandemic to explore the health staff's knowledge, attitudes, and precautions in 13 health facilities. The aim was to assess LWM in the context of COVID-19 pandemic in the Buea Health District.

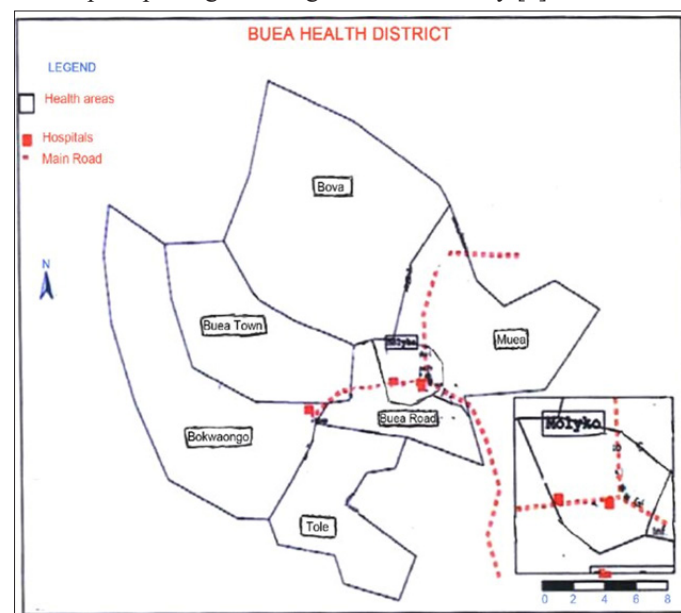
## Methods

### Study Design

This was a prospective observational and Laboratory-based study, capturing the knowledge, attitudes and precautions taken by healthcare workers directly concerned with Laboratory waste management in the context of COVID-19 pandemic. The investigation was carried out for a period of 4 months from 2nd March to 30th June, 2022.

### Study Area and Setting

This study was carried out in Buea Health District (BHD) located in Buea, Fako Division of the South West Region of Cameroon. The BHD has 7 health areas (namely Muea, Molyko, Buea Road, Buea town, Tole, Bokwaongo and Bova) (Figure 1) with over 37 health facilities as per the report of the regional delegation of public health. Within these seven health areas, our study sites were 13 health facilities. Buea has two major seasons; a rainy season that begins in March and ends in October, and a dry season that begins in November and ends in February. Annual rainfall varies from 3000 to 5000 mm. Buea has an estimated population of 300,000 inhabitants constituting essentially of the Bakweris (the indigenes) and a highly cosmopolitan population within the urban space putting the indigenes at a minority [9].



**Figure 1:** Map of Buea Health District [9]

The study was conducted at the Buea COVID-19 treatment and testing Centres: Molyko Integrated Health Centre, Great Soppo Integrated Health Centre, CMA Muea, Bokwango Integrated Health Centre, Buea Regional Hospital, Bokova Integrated Health Centre, Mount Mary Catholic Hospital, Good Samaritan Health Center, Kawa Sumbele Medical Clinic, Life Span Nursing Home, Restoration Foundation Clinic, Solidarity Clinic Molyko and St Veronica Medical Centre.

### Inclusion Criteria

Health personnel directly concerned with waste disposal (Laboratory technicians, nurses, doctors, respiratory therapist) in the thirteen randomly selected hospitals in the BHD were included, after having given their authorization by signing the informed consent form.

### Sample Size Calculation

The sample size for questionnaire administration was calculated using the Lorenz formula [10]. The sample size of the study was calculated using a single population proportion formula with the 20% of healthcare workers who knew how to manage waste in the context of COVID-19 pandemic, at confidence level of 95%, and a margin of error at 5% [10, 11].

$$n = \frac{Z^2 p (1-p)}{e^2}$$

$$(n) = \left( \frac{(1.96)^2 \times (0.2) \times (0.8)}{(0.05)^2} \right) = 245.9 \sim 246 \text{ (males and females).}$$

Where;

n= expected maximum sample size,

e = precision= 0.05 (5%),

z= standard normal variation which was set at 1.96 (p value: 0.05 and 95% confidence interval),

p = proportion of health personnel involved in LWM in the context of COVID-19 pandemic.

### Sampling Technique

The 7 health areas of BHD have 37 health facilities. A random probability sampling technique was used in the selection process. In each of the facilities, a simple random sampling technique was used to select the participants. In addition, a simple random sampling was used to equally select the participants based on staff present in the health facility.

### Study Procedure

Collection of data was done where informed consent was sought from health personnel being present during the administration of questionnaires. It was administered during morning and evening. Informed consent and questions were written in English language.

An observational checklist was got from WHO [12]. Where the level of knowledge, attitude and precautions taken by healthcare workers in the context of COVID-19 pandemic were observed. It was done in all the 13 selected health facilities in the BHD.

### Pretesting of Questionnaire and Data Management

A minimum of 15 structured questionnaires were administered two weeks before the start date of the research in Tiko Health District to other healthcare workers in different health facilities. This was

done in-order to check the language, flow and comprehension of the questions. After the pre-test, modifications were made to ensure that the questions were comprehensible and interpreted as intended in the given locality. The length of each interview was approximately 10 minutes. After this process the questionnaire were carried to the required area of study (Buea Health District). The revised questionnaire was used for data collection. These were coded and administered to participants. Questionnaires were checked for proper completion and validated at the end of each day. Questionnaires with > 20% unanswered questions were rejected. Data was keyed into Microsoft excel and then imported to Statistical package for social sciences (SPSS). Data logged in to MS excel was checked for normality and saved in a flash drive. Furthermore, the questionnaires were kept in a confined cupboard so as to ensure confidentiality.

### Statistical Analysis

Data was imported into SPSS version 25.0 for analysis. Knowledge, attitudes and precautions taken on LWM score were rated based on the questions that were asked, any correct answer scored a 1 and a wrong answer scored a 0. For each section healthcare workers who scored more than half (50%) of the total marks were considered as having a good level of knowledge, good attitudes or took precautions while handling LW. Those with a score < 50% were regarded as having a poor level of knowledge, poor attitudes or did not take good precautions while handling LW in the context of COVID-19 pandemic. In-order to select the best predictors to be used as variables for the study, we carried out descriptive statistics for both categorical and continuous variables (age, sex, profession category, educational status and work experience) which included making a frequency table for categorical variables which was measured as percentages and summary statistics for continuous variable expressed as mean, standard deviation.

Bivariate analysis was carried out on questions on knowledge, attitudes and precautions taken while handling Laboratory waste in the context of COVID-19 pandemic. This was done to check if there was any association between the response and predictors. The bivariate analysis helped us select important variables to be fitted in the univariate analysis. It also helped to identify which variable is significantly associated to the response (knowledge,

attitudes and precautions taken while handling LW in the context of COVID-19 pandemic). Variables with a p-value < 0.20 in bivariate analysis were included into multivariate analysis. Furthermore, the multivariate logistic regression model analysis of the variables (Improper medical waste segregation and management, and use of personal protective equipment (PPE)) to control for confounders was done considering p-value < 0.05 to be significant. Odds ratios (OR), Coefficient and 95% confidence intervals (CIs) were used when determining the association of the different variables with the level of knowledge, attitudes and precautions taken while handling LW. Statistical significance was considered at p-value < 0.05.

### Ethical Consideration

Ethical Clearance was obtained from the Institutional Review Board of the Faculty of Health Sciences, University of Buea. Administrative Authorizations were obtained from the Regional Delegation of Public Health, South West Region, the District Health Service in Buea (Cameroon) and the different health facilities offering LWM services within BHD. Written consent was sought from study participants before they were enrolled in the study. Data collected was stored confidentially and used only for study purpose.

### Results

#### Demographic Characteristics of the Healthcare Providers

Table 1 shows demographic characteristics of our study population. Regarding the occupational status of the HCWs, 142 (56.8%) were Laboratory technicians (LT), 160 (64.0%) were in the age of 18–30 years, and the majority of the participants, 202 (80.8%), were females. All the participants had a college or university degree ranging from Diploma (MLT), 152 (60.8 %), as their highest educational qualification. They were 60 (24.0 %) nurses, 12 (4.8 %) were physicians, 18 (7.2%) were nurses on internship, 8 (3.2%) were LT on internship and 10 (4.0 %) respiratory therapists (RT). Furthermore, (52.9 %) HCWs had a minimum of six months to one year of experience, 132 (52.8%) had 8 months to 1 year of experience and 33 (13.2%) had 11 to 22 years of experience. Concerning the working place, most of the participants, 92 (36.8%), worked in a government hospital.

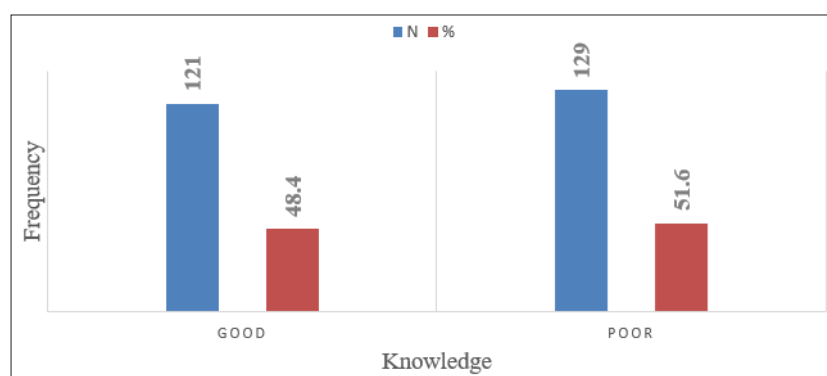
**Table 1: Demographic characteristics of the healthcare workers (N = 250)**

| Variable                  |                            | N (%)      |
|---------------------------|----------------------------|------------|
|                           | Muslim                     | 8 (3.2)    |
|                           | Christians                 | 242 (96.8) |
| Age Group                 | 18-30                      | 160 (64.0) |
|                           | 31-40                      | 60 (24.0)  |
|                           | 41-50                      | 30 (12.0)  |
| Sex                       | Female                     | 202 (80.8) |
|                           | Male                       | 48 (19.2)  |
| Marital Status            | Married                    | 97 (38.8)  |
|                           | Single                     | 153 (61.2) |
| Educational Qualification | Advanced Level             | 28 (11.2)  |
|                           | Bachelor                   | 44 (17.6)  |
|                           | Diploma (MLT)              | 152 (60.8) |
|                           | Doctorate                  | 12 (4.8)   |
|                           | Masters                    | 6 (2.4)    |
|                           | Others                     | 8 (3.2)    |
| Profession                | Intern (Nurse)             | 18 (7.2)   |
|                           | Laboratory Technician (LT) | 142 (56.8) |
|                           | Nurse                      | 60 (24.0)  |
|                           | Intern (Laboratory)        | 8 (3.2)    |
|                           | Respiratory Therapist (RT) | 10 (4.0)   |
|                           | Physician                  | 12 (4.8)   |

|                                     |                                                                         |                                                               |
|-------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------|
| Residence                           | Urban<br>Rural                                                          | 382 (87.2)<br>32 (12.8)                                       |
| Classification Of Health Facilities | Public/Government Service<br>Confessional<br>Private                    | 129 (51.6)<br>18 (7.2)<br>103 (41.2)                          |
| Years Of Experience                 | 6 Months to 1 Year<br>2-4 Years<br>5-7 Years<br>8-10 Years<br>>10 Years | 132 (52.8)<br>34 (13.6)<br>32 (12.8)<br>19 (7.6)<br>33 (13.2) |
| Type Of Health Facility             | Hospital<br>Health Center<br>Clinic                                     | 92 (36.8)<br>77 (30.8)<br>81 (32.4)                           |

### Knowledge Level of the Healthcare Workers on Laboratory Waste

The overall knowledge level of HCWs is shown in Figure 2, in which; 121 (48.40%) had good knowledge, and 129 (51.60%) had poor knowledge.



**Figure 2:** Knowledge level of healthcare workers about Laboratory waste management  
N—number; %—percentage

The detailed information on the knowledge level of HCWs about LWM in the context of COVID-19 is presented in Table 2. A greater proportion of HCWs, 226 (90.4%) had a good level of knowledge in the management practices and protocol for sharps waste, such as needles or blades. Approximately 139 (55.6) knew the procedures and protocols for processing of equipment for reuse. With regards to the policies and procedures that are used for managing routine (i.e., non-emergency) Laboratory services that are adaptable to an emergency situation, 100 (40.0%) had a good understanding. Also, 157 (62.8%) knew that all Laboratory staff members must prepare job action sheets describing their roles and tasks in an emergency situation. Approximately 140 (56.0%) had a good level of knowledge in Laboratory biosafety measures at their health facilities and its compliance with national guidelines or the guidelines provided in the WHO Laboratory biosafety manual. Regarding LWM and cleaning among other hospital activities, 192 (76.8%) knew it was a high priority. They were 126 (40.4%) who had a good level of understanding concerning WHO guidelines for collecting, preserving, and shipping specimens. Furthermore, 148 (59.2%) knew the standardized Laboratory procedures, checklists, forms, and log sheets used in their health facilities. Some, 168 (67.2%) knew the effective and correct way to dispose sharps waste and 134 (53.6%) knew that the surveillance tool used in their institution is effective to prevent or control infection. A few, 99 (39.6%) knew if their health facilities established and maintained agreements with other laboratories, to cope with increased demand for Laboratory services and only 96 (38.4%) knew if Laboratory management in their hospital cooperates with other hospitals and throughout national, regional, and international Laboratory networks.

**Table 2: Knowledge level of health care providers about Laboratory waste management (N=250)**

| Variable                                                                                                                                              | Knowledge | N (%)      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| 1. The management practices and protocol for sharps waste, such as needles or blades.                                                                 | Unclear   | 18 (7.2)   |
|                                                                                                                                                       | No        | 6 (2.4)    |
|                                                                                                                                                       | Yes       | 22 (69.4)  |
| 2. The procedures and protocols for processing of equipment's for reuse.                                                                              | Unclear   | 46 (18.4)  |
|                                                                                                                                                       | No        | 65 (26.0)  |
|                                                                                                                                                       | Yes       | 139 (55.6) |
| 3. Policies and procedures that are used for managing routine (i.e., non-emergency) Laboratory services that are adaptable to an emergency situation. | Unclear   | 116 (46.4) |
|                                                                                                                                                       | No        | 34 (13.6)  |
|                                                                                                                                                       | Yes       | 100 (40.0) |



|                                                                                                                                                                                              |                      |                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------|
| 4. All Laboratory staff members must prepare job action sheets describing their roles and tasks in an emergency situation.                                                                   | Unclear<br>No<br>Yes | 71 (28.4)<br>22 (8.8)<br>157 (62.8)  |
| 5. Laboratory biosafety measures of your institution and its compliance with national guidelines or the guidelines provided in the WHO Laboratory biosafety manual (third edition, WHO 2004) | Unclear<br>No<br>Yes | 70 (28.0)<br>40 (16.0)<br>140 (56.0) |
| 6. Laboratory waste management and cleaning are high priorities among the hospital's activities.                                                                                             | Unclear<br>No<br>Yes | 22 (8.8)<br>36 (14.4)<br>192 (76.8)  |
| 7. WHO guidelines for collecting, preserving, and shipping specimens.                                                                                                                        | Unclear<br>No<br>Yes | 61 (24.4)<br>63 (25.2)<br>126 (50.4) |
| 8. Standardized Laboratory procedures, checklists, forms, and log sheets used in your hospital.                                                                                              | Unclear<br>No<br>Yes | 53 (21.2)<br>49 (19.6)<br>148 (59.2) |
| 9. Laboratory staffs receive training.                                                                                                                                                       | Unclear<br>No<br>Yes | 40 (16.0)<br>22 (8.8)<br>188 (75.2)  |
| 10. Provision of waste management, cleaning and laundry services should have been trained in infection prevention and control by healthcare providers                                        | Unclear<br>No<br>Yes | 51 (20.4)<br>9 (3.6)<br>190 (76.0)   |
| 11. The effective and correct way to dispose sharps waste.                                                                                                                                   | Unclear<br>No<br>Yes | 14 (5.6)<br>68 (27.2)<br>168 (67.2)  |
| 12. Surveillance tool used in your institution is effective to prevent or control infection.                                                                                                 | Unclear<br>No<br>Yes | 54 (21.6)<br>622 (4.8)<br>134 (53.6) |
| 13. The hospital established and maintained agreements with other laboratories, to cope with increased demand for Laboratory services.                                                       | Unclear<br>No<br>Yes | 121 (48.4)<br>30 (12.0)<br>99 (39.6) |

N—total number; n—frequency; %—percentage.

### Attitudes of the Healthcare Workers Towards Laboratory Waste Management

The results showed that 212 (84.8%) had a favourable attitude, and 38 (15.2%) had an unfavourable attitude towards LWM. Table 3 shows details on attitudes on HCWs. Among the participants, most of the Laboratory technicians 126 (50.4%) and nurses 60 (24.0%) had a more favourable attitudes than others. More, 171 (68.4%) HCWs were neutral on the fact that the safe disposal of Laboratory waste was necessary for healthcare areas. Approximately 157 (62.8%) HCWs agreed that LWM required teamwork. Only 100 (40.0%) were neutral that LWM created an extra burden on their work. Most of HCWs, 122 (48.3%), were neutral that LWM risked transmitting infectious diseases. Also, 81 (32.4%) were neutral that the segregation of hospital waste into different categories was time consuming. Approximately 85 (34.0%) HCWs felt that PPE must be used while handling Laboratory waste, and 121 (88.4%) were neutral that decontamination and disinfection reduced infection. More, 104 (41.6%), strongly disagreed that proper Laboratory waste management enhanced the quality assurance of healthcare sectors, and 87 (34.8%) strongly agreed that upgraded knowledge on LWM was mandatory.

**Table 3: Indicators of the Attitudes of the Health Care Workers towards Laboratory Waste Management (N = 250)**

| S/N | Attitudes Questions                                                      | Strongly Agree | Agree         | Neutral       | Disagree     | Strongly Disagree |
|-----|--------------------------------------------------------------------------|----------------|---------------|---------------|--------------|-------------------|
|     |                                                                          | n (%)          | n (%)         | n (%)         | n (%)        | n (%)             |
| 1.  | Safe disposal of Laboratory waste (LW) is necessary in healthcare areas. | 6<br>(2.4)     | 51<br>(20.4)  | 171<br>(68.4) | 22<br>(8.8)  | 0<br>(0.0)        |
| 2.  | LWM is a team work.                                                      | 157<br>(62.8)  | 85<br>(34.0)  | 4<br>(1.6)    | 2<br>(0.80)  | 2<br>(0.8)        |
| 3.  | LWM creates extra burden on my work. *                                   | 30<br>(12.0)   | 100<br>(40.0) | 26<br>(10.4)  | 88<br>(35.2) | 6<br>(2.4)        |
| 4.  | LWM is risk to transmit any infectious diseases. *                       | 48<br>(19.2)   | 122<br>(48.8) | 8<br>(3.2)    | 52<br>(20.8) | 20<br>(8.0)       |
| 5.  | Segregate hospital waste into different categories is time consuming. *  | 36<br>(14.4)   | 81<br>(32.4)  | 40<br>(16.0)  | 79<br>(31.6) | 14<br>(5.6)       |

|     |                                                                         |              |               |              |              |              |
|-----|-------------------------------------------------------------------------|--------------|---------------|--------------|--------------|--------------|
| 6.  | PPE is must while handling biomedical waste.                            | 85<br>(34.0) | 66<br>(26.4)  | 38<br>(15.2) | 29<br>(11.6) | 32<br>(12.8) |
| 7.  | Decontaminations and disinfections reduces the spread of the infection. | 70<br>(28.0) | 121<br>(88.4) | 26<br>(10.4) | 16<br>(6.4)  | 17<br>(6.8)  |
| 8.  | Use of colour code for segregation of wastes are must.                  | 73<br>(29.2) | 112<br>(44.8) | 20<br>(8.0)  | 43<br>(17.2) | 2<br>(0.8)   |
| 9.  | Proper LW enhance the quality assurance of healthcare sectors.          | 94<br>(37.6) | 104<br>(41.6) | 12<br>(4.8)  | 14<br>(5.6)  | 26<br>(10.4) |
| 10. | Upgrade knowledge on LW is mandatory.                                   | 87<br>(34.8) | 81<br>(32.4)  | 32<br>(12.8) | 46<br>(18.4) | 4<br>(1.6)   |

N—total number; n—frequency; %—percentage; LW: Laboratory waste; LWM: Laboratory Waste Management. \* Negatively phrased statements were reversely scored.

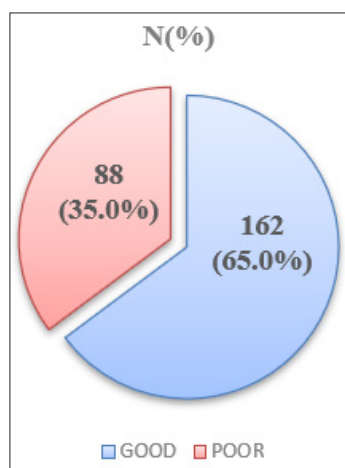
### Precautions Taken by Healthcare Providers in Laboratory Waste Management

The practice of HCWs in Laboratory waste management is reported in Figure 3. Practically, 162 (65.0%) health personnel took good precautions while handling Laboratory waste. Most of the HCWs, 115 (46.0%), always followed the guidelines specified by the Ministry of Public Health for LWM. Approximately, 182 (72.8%) HCWs always adhered to the infection control policies while treating COVID-19 patients. Most of the HCWs, 170 (68.0%), always used and discarded all PPE while handling LW. Approximately, 127 (50.8%) HCWs followed the colour coding of containers according to the type of waste during the disposal of LW and 163 (65.2%) followed policies in separating the wastes into non-hazardous, hazardous; and sharp waste. Regarding preventing sharps related injury such as avoiding recapping used needles, 236 (94.4%) HCWs were cautious and 200 (80.0%) HCWs prevented contamination. Regarding the training for health staff handling items of covid-19 patients and other non-covid-19 patients, 181 (72.4%) always take precautions (Table 4).

**Table 4: Indicators of precautions taking on Laboratory Waste Management (N=250)**

| Variable                                                                                                                                               | Value label | n   | %    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|------|
| 1. Follow guidelines laid down by ministry of health for Laboratory waste management in the context of covid-19 pandemic management.                   | Always      | 127 | 50.8 |
|                                                                                                                                                        | Never       | 8   | 3.2  |
|                                                                                                                                                        | Sometimes   | 115 | 46.0 |
| 2. Adherence to the infection control policy while handling covid-19 patients.                                                                         | Always      | 182 | 72.8 |
|                                                                                                                                                        | Never       | 28  | 11.2 |
|                                                                                                                                                        | Sometimes   | 40  | 16.0 |
| 3. Use all personal protective equipment while handling biomedical wastes.                                                                             | Always      | 143 | 57.2 |
|                                                                                                                                                        | Never       | 6   | 2.4  |
|                                                                                                                                                        | Sometimes   | 101 | 40.4 |
| 4. Discard all personal protective equipment after handling biomedical wastes.                                                                         | Always      | 170 | 68.0 |
|                                                                                                                                                        | Never       | 34  | 13.6 |
|                                                                                                                                                        | Sometimes   | 46  | 18.4 |
| 5. Do proper hand hygiene before and after every procedure and frequently.                                                                             | Always      | 181 | 72.4 |
|                                                                                                                                                        | Never       | 8   | 3.2  |
|                                                                                                                                                        | Sometimes   | 61  | 24.4 |
| 6. Do colour coding of containers according to the type of wastes while for disposing Laboratory waste management in the context of covid-19 pandemic. | Always      | 127 | 50.8 |
|                                                                                                                                                        | Never       | 53  | 21.2 |
|                                                                                                                                                        | Sometimes   | 70  | 28.0 |
| 7. Policies separating Laboratory waste management in the context of covid-19 pandemic as non-hazardous, hazardous, and sharp waste in segregation.    | Always      | 163 | 65.2 |
|                                                                                                                                                        | Never       | 6   | 2.4  |
|                                                                                                                                                        | Sometimes   | 81  | 32.4 |
| 8. Maintain Laboratory waste management in the context of covid-19 pandemic records.                                                                   | Always      | 177 | 57.6 |
|                                                                                                                                                        | Never       | 41  | 16.4 |
|                                                                                                                                                        | Sometimes   | 65  | 26.0 |
| 9. Take care in preventing sharp related injury like avoid recapping used needle.                                                                      | Always      | 236 | 94.4 |
|                                                                                                                                                        | Never       | 6   | 2.4  |
|                                                                                                                                                        | Sometimes   | 8   | 3.2  |
| 10. Prevent contamination while handling items of covid-19 patients and other non-covid-19 patients.                                                   | Always      | 200 | 80.0 |
|                                                                                                                                                        | Never       | 22  | 8.8  |
|                                                                                                                                                        | Sometimes   | 28  | 11.2 |
| 11. Training for health staff handling items of covid-19 patients and other non-covid-19 patients.                                                     | Always      | 181 | 72.4 |
|                                                                                                                                                        | Never       | 69  | 27.6 |
|                                                                                                                                                        | Sometimes   | 0   | 0.0  |

N—total number; n: frequency, %—percentage.



**Figure 3:** Precautions taking by Health care workers on Laboratory waste Management

N—number; %—percentage

#### Association of the Knowledge of Healthcare Workers on Laboratory Waste Management with Demographic Variables

Table 5 shows that there was a significant association between the level of knowledge and some demographic parameters. These include: age group ( $p < 0.001$ ), years of experience ( $p < 0.001$ ), residence ( $p < 0.001$ ), religion ( $p < 0.001$ ), educational qualification ( $p < 0.001$ ), classification of this health ( $p < 0.001$ ), name of health facility ( $p < 0.001$ ) and profession ( $p < 0.001$ ).

**Table 5:** Association of the knowledge of healthcare workers towards Laboratory Waste Management in the context of COVID-19 with demographic variables (N = 250)

| Variable                          |                           | Good level of Knowledge, n (%) | Poor level of Knowledge, n (%) | Chi-square p-value |
|-----------------------------------|---------------------------|--------------------------------|--------------------------------|--------------------|
| Age group                         | 18-30                     | 82 (32.8)                      | 78 (31.2)                      | 19.31<br>0.00      |
|                                   | 31-40                     | 30 (12.0)                      | 30 (12.0)                      |                    |
|                                   | 41-50                     | 28 (11.2)                      | 2 (0.8)                        |                    |
| Years of experience               | 6 months to 1 year        | 78 (31.2)                      | 54 (21.6)                      | 34.25<br>0.00      |
|                                   | 2-4 years                 | 12 (4.8)                       | 22 (8.8)                       |                    |
|                                   | 5-7 years                 | 10 (4.0)                       | 22 (8.8)                       |                    |
|                                   | 8-10 years                | 9 (3.6)                        | 10 (4.0)                       |                    |
|                                   | >10 years                 | 31 (12.4)                      | 2 (0.8)                        |                    |
| Residence                         | Rural                     | 21 (8.4)                       | 11 (4.4)                       | 39.90<br>0.00      |
|                                   | Urban                     | 119 (47.6)                     | 99 (39.6)                      |                    |
| Religion                          | Christian                 | 140 (56.0)                     | 102 (40.8)                     | 165.07<br>0.00     |
|                                   | Muslim                    | 0 (0.0)                        | 8 (3.2)                        |                    |
| Educational qualification         | Advanced level            | 20 (8.0)                       | 8 (3.2)                        | 25.2<br>0.00       |
|                                   | Bachelor                  | 31 (12.4)                      | 13 (5.2)                       |                    |
|                                   | Diploma (MLT)             | 81 (32.4)                      | 71 (28.4)                      |                    |
|                                   | Doctorate                 | 4 (1.6)                        | 8 (3.2)                        |                    |
|                                   | Masters                   | 4 (1.6)                        | 0 (0.0)                        |                    |
|                                   | Others                    | 0 (0.0)                        | 8 (3.2)                        |                    |
| Marital status                    | Married                   | 57 (22.8)                      | 40 (16.0)                      | 0.49<br>0.48       |
|                                   | Single                    | 83 (33.2)                      | 70 (28.0)                      |                    |
| Sex                               | Female                    | 114 (45.6)                     | 88 (35.2)                      | 0.81<br>0.78       |
|                                   | Male                      | 26 (10.4)                      | 22 (8.8)                       |                    |
| Classification of health facility | Public/government service | 77 (30.8)                      | 52 (20.8)                      | 67.37<br>0.00      |
|                                   | Private                   | 63 (25.2)                      | 40 (16.0)                      |                    |
|                                   | Others                    | 0 (0.0)                        | 18 (7.2)                       |                    |

|                         |                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                     |                                                                                                                                                  |                |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Name of health facility | Bokova Integrated Health Centre<br>Bokwoango Integrated Health Centre<br>Buea Regional Hospital<br>Buea town Integrated Health Centre<br>CMA Muea<br>Great Soppo Integrated Health Centre<br>Kawa Sumbele Medical Clinic<br>Life Span Nursing Home<br>Molyko Integrated Health Centre<br>Mount Mary Catholic Hospital<br>Restoration Clinic<br>Solidarity Clinic Molyko<br>St. Veronica | 8 (3.2)<br>0 (0.0)<br>28 (11.2)<br>1 (0.4)<br>24 (9.6)<br>0 (0.0)<br>16 (6.4)<br>0 (0.0)<br>16 (6.4)<br>0 (0.0)<br>18 (7.2)<br>18 (7.2)<br>11 (4.4) | 0 (0.0)<br>6 (2.4)<br>0 (0.0)<br>2 (28.8)<br>0 (0.0)<br>24 (9.6)<br>0 (0.0)<br>40 (16.0)<br>0 (0.0)<br>18 (7.2)<br>0 (0.0)<br>0 (0.0)<br>0 (0.0) | 246,12<br>0.00 |
| Profession              | Intern (nurse)<br>Laboratory technician<br>Nurse<br>Nurse intern<br>Pharmacist<br>Physician                                                                                                                                                                                                                                                                                             | 0 (0.0)<br>98 (39.2)<br>36 (14.4)<br>0 (0.0)<br>2 (0.8)<br>4 (1.6)                                                                                  | 18 (7.2)<br>44 (17.6)<br>24 (9.6)<br>8 (3.2)<br>8 (3.2)<br>8 (3.2)                                                                               | 51.00<br>0.00  |

N—total number; n—frequency, %—percentage; MLT: Medical Laboratory Technician.

#### Association of the Attitude of Healthcare Workers on Laboratory Waste Management with Demographic Variables

Table 6 shows that there was a significant association between the attitude of health care workers towards Laboratory Waste Management in the context of COVID-19 pandemic and some demographic parameters. These includes: age group ( $p = 0.09$ ), years of experience ( $p < 0.001$ ), residence ( $p = 0.05$ ), religion ( $p < 0.001$ ), educational qualification ( $p < 0.001$ ), sex ( $p = 0.01$ ), classification of the health facility ( $p < 0.001$ ), name of health facility ( $p < 0.001$ ) and profession ( $p < 0.001$ ).

**Table 6: Association of the attitudes of healthcare workers towards Laboratory waste management in the context of COVID-19 with demographic variables (N = 250)**

| Variable                  |                                                                               | Good Attitudes<br>n (%)                                               | Poor attitudes<br>n (%)                                          | Chi-square<br>p-value |
|---------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------|
| Age group                 | 18-30<br>31-40<br>41-50                                                       | 128 (51.2)<br>44 (17.6)<br>30 (12.0)                                  | 32 (12.8)<br>16 (6.4)<br>0 (0.0)                                 | 9.35<br>0.01          |
| Years of experience       | 6 months to 1 year<br>2-4 years<br>5-7 years<br>8-10 years<br>>10 years       | 108 (43.2)<br>26 (10.4)<br>16 (6.4)<br>19 (7.6)<br>33 (13.2)          | 24 (9.6)<br>8 (3.2)<br>16 (6.4)<br>0 (0.0)<br>0 (0.0)            | 32.42<br>0.00         |
| Residence                 | Rural<br>Urban                                                                | 24 (9.6)<br>173 (69.2)                                                | 8 (3.2)<br>40 (16.0)                                             | 10.78<br>0.05         |
| Religion                  | Christian<br>Muslim                                                           | 194 (77.6)<br>8 (3.2)                                                 | 48 (19.2)<br>0 (0.0)                                             | 121.71<br>0.00        |
| Educational qualification | Advanced level<br>Bachelor<br>Diploma (MLT)<br>Doctorate<br>Masters<br>Others | 28 (11.2)<br>36 (14.4)<br>120 (48.0)<br>4 (1.6)<br>6 (2.4)<br>8 (3.2) | 0 (0.0)<br>8 (3.2)<br>32 (12.8)<br>8 (3.2)<br>0 (0.0)<br>0 (0.0) | 27.77<br>0.00         |
| Marital status            | Married<br>Single                                                             | 81 (32.4)<br>121 (48.4)                                               | 16 (6.4)<br>32 (12.8)                                            | 0.75<br>0.39          |
| Sex                       | Female<br>Male                                                                | 170 (68.0)<br>32 (12.8)                                               | 32 (12.8)<br>16 (6.4)                                            | 7.65<br>0.01          |



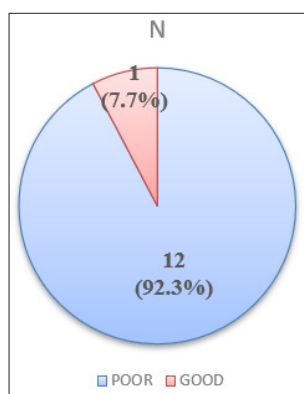
|                                       |                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                        |                                                                                                                                    |                |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Classification of the health Facility | Public/government service<br>Private<br>Others                                                                                                                                                                                                                                                                                                                                       | 129 (51.6)<br>63 (25.2)<br>10 (4.0)<br>51.6<br>25.2<br>4.0                                                                                             | 0 (0.0)<br>40 (16.0)<br>8 (3.2)<br>0<br>16<br>3.2                                                                                  | 63.64<br>0.00  |
| Name of health facility               | Bokova Integrated Health Centre<br>Bokwoango Integrated Health Centre<br>Buea Regional Hospital<br>Buea Town Integrated Health Centre<br>Cma Muea Great Soppo Integrated Health Centre<br>Kawa Sumbele Medical Clinic<br>Life Span Nursing Home<br>Molyko Integrated Health Centre<br>Mount Mary Catholic Hospital<br>Restoration Clinic<br>Solidarity Clinic<br>Molyko St. Veronica | 8 (3.2)<br>6 (2.4)<br>28 (11.2)<br>23 (9.2)<br>24 (9.6)<br>24 (9.6)<br>16 (6.4)<br>0 (0.0)<br>16 (6.4)<br>10 (4.0)<br>18 (7.2)<br>18 (7.2)<br>11 (4.4) | 0 (0.0)<br>0 (0.0)<br>0 (0.0)<br>0 (0.0)<br>0 (0.0)<br>0 (0.0)<br>40 (16.0)<br>0 (0.0)<br>8 (3.2)<br>0 (0.0)<br>0 (0.0)<br>0 (0.0) | 121.35<br>0.00 |
| Profession                            | Intern (nurse)<br>Laboratory technician<br>Nurse<br>Nurse intern<br>Pharmacist<br>Physician                                                                                                                                                                                                                                                                                          | 2 (0.8)<br>126 (50.4)<br>60 (24.0)<br>8 (3.2)<br>2 (0.8)<br>4 (1.6)                                                                                    | 16 (6.4)<br>16 (6.4)<br>0 (0.0)<br>0 (0.0)<br>8 (3.2)<br>8 (3.2)                                                                   | 119.52<br>0.00 |

N—total number; n — frequency, %—percentage; MLT: Medical Laboratory Technician.

**Association of the Precautions Taken by of Healthcare Workers on Laboratory Waste Management with Demographic Variables**  
Table 7 shows that there was a significant association between the precautions taken by health care workers towards LWM in the context of COVID-19 pandemic and some demographic parameters, like age group ( $p = 0.04$ ), years of experience ( $p < 0.001$ ), residence ( $p < 0.001$ ), religion ( $p < 0.001$ ), educational qualification ( $p < 0.001$ ), classification of the health facility ( $p < 0.001$ ), name of health facility ( $p < 0.001$ ) and profession ( $p < 0.001$ ).

### World Health Organization's COVID-19 Waste Management Checklist

With regards to WHO guidelines, generally LWM at 13 health facilities in the BHD did not conform to WHO guidelines. The results showed that majority, 12 (92.3%) health facilities had a poor level of knowledge, attitudes and practice and only 1 (7.7%) health facility had a good level of knowledge, attitudes and practice towards LWM as showed in Figure 4.



**Figure 4:** Descriptive analysis on World Health Organisation checklist

N—number; %—percentage.

**Table 7: Association of the precautions taken by healthcare workers towards Laboratory Waste Management in the context of COVID-19 with demographic variables (N = 250)**

| Variable                              |                                    | Precautions |            |                    |
|---------------------------------------|------------------------------------|-------------|------------|--------------------|
|                                       |                                    | Good n (%)  | Poor n (%) | Chi-square p-value |
| Age group                             | 18-30                              | 110 (44.0)  | 50 (20.0)  | 0.63               |
|                                       | 31-40                              | 51 (20.4)   | 9 (3.6)    | 0.04               |
|                                       | 41-50                              | 24 (9.6)    | 6 (2.4)    |                    |
| Years of experience                   | 6 months to 1 year                 | 96 (38.4)   | 36 (14.4)  | 40.19              |
|                                       | 2-4 years                          | 26 (10.4)   | 8 (3.2)    | 0.00               |
|                                       | 5-7 years                          | 32 (12.8)   | 0 (0.0)    |                    |
|                                       | 8-10 years                         | 4 (1.6)     | 15 (6.0)   |                    |
|                                       | >10 years                          | 27 (10.8)   | 6 (2.4)    |                    |
| Residence                             | Rural                              | 32 (12.8)   | 0 (0.0)    | 17.60              |
|                                       | Urban                              | 121 (48.4)  | 91 (36.4)  | 0.00               |
| Religion                              | Christian                          | 185 (74.0)  | 57 (22.8)  | 35.79              |
|                                       | Muslim                             | 0 (0.0)     | 8 (3.2)    | 0.00               |
| Educational qualification             | Advanced level                     | 18 (7.2)    | 10 (4.0)   | 34.02              |
|                                       | Bachelor                           | 38 (15.2)   | 6 (2.4)    | 0.00               |
|                                       | Diploma (MLT)                      | 111 (44.4)  | 41 (16.4)  |                    |
|                                       | Doctorate                          | 12 (4.8)    | 0 (0.0)    |                    |
|                                       | Masters                            | 6 (2.4)     | 0 (0.0)    |                    |
|                                       | Others                             | 0 (0.0)     | 8 (3.2)    |                    |
| Marital status                        | Married                            | 67 (26.8)   | 30 (12.0)  | 2.00               |
|                                       | Single                             | 118 (47.2)  | 35 (14.0)  | 0.00               |
| Sex                                   | Female                             | 143 (57.2)  | 59 (23.6)  | 5.62               |
|                                       | Male                               | 42 (16.8)   | 6 (2.4)    | 0.12               |
| Classification of the health facility | Public/government service          | 78 (31.2)   | 51 (20.4)  | 38.13              |
|                                       | Private                            | 89 (35.6)   | 14 (5.6)   | 0.00               |
|                                       | Others                             | 18 (7.2)    | 0 (0.0)    |                    |
| Name of health facility               | Bokova Integrated Health Centre    | 8 (3.2)     | 0 (0.0)    | 94.76              |
|                                       | Bokwoango Integrated Health Centre | 6 (2.4)     | 0 (0.0)    | 0.00               |
|                                       | Buea Regional Hospital             | 22 (8.8)    | 6 (2.4)    |                    |
|                                       | Buea Town Integrated Health Centre | 6 (2.4)     | 17 (6.8)   |                    |
|                                       | CMA Muea                           | 12 (4.8)    | 12 (4.8)   |                    |
|                                       | Great Soppo                        | 8 (3.2)     | 16 (6.4)   |                    |
|                                       | Kawa Sumbele Medical Clinic        | 10 (4.0)    | 6 (2.4)    |                    |
|                                       | Life Span Nursing Home             | 40 (16.0)   | 0 (0.0)    |                    |
|                                       | Molyko Integrated Health Centre    | 16 (6.4)    | 0 (0.0)    |                    |
|                                       | Mount Mary Catholic Hospital       | 18 (7.2)    | 0 (0.0)    |                    |
|                                       | Restoration Clinic                 | 12 (4.8)    | 6 (2.4)    |                    |
|                                       | Solidarity Clinic Molyko           | 18 (7.2)    | 0 (0.0)    |                    |
|                                       | St. Veronica                       | 9 (3.6)     | 2 (0.8)    |                    |
|                                       | Intern (nurse)                     | 18 (7.2)    | 0 (0.0)    | 38.38              |
|                                       | Laboratory technician              | 99 (39.6)   | 43 (17.2)  | 0.00               |
|                                       | Nurse                              | 46 (18.4)   | 14 (5.6)   |                    |
| Profession                            | Nurse intern                       | 0 (0.0)     | 8 (3.2)    |                    |
|                                       | Pharmacist                         | 10 (4.0)    | 0 (0.0)    |                    |
|                                       | Physician                          | 12 (4.8)    | 0 (0.0)    |                    |

N—total number; n — frequency, %—percentage; MLT: Medical Laboratory Technician.

## Discussion

### The Healthcare Providers Knowledge, Attitudes and Practice about Laboratory Waste Management

During the COVID-19 pandemic, many government agencies, including Ministry of Public Health, had published guidelines for the management of waste produced during the treatment, diagnosis and isolation of COVID-19 patients. Our study was conducted to assess the knowledge, attitudes and practice/precautions on LWM among HCWs in BHD. Our study reported that 48.4 % had good knowledge. COVID-19-related waste needed special attention, as this disease had prevailed globally since 2019 in an unprecedented manner. Its unknown dimensions and many mutations ever since had increased the risk of infection. Thus, the infected waste, which could largely transmit the disease, needed special care. Studies have shown that the virus can survive on solid surfaces for long, up to 72 h on plastic for example [13,14,15]. Therefore, a delay of more than 72h in collecting the infectious waste can increase the chances of virus transmission, especially to waste collection workers. In the meantime, it was shown that future policies to reduce PPE consumption with the intent of reducing the environmental impact could be by laying emphasis on key infection control measures (cohorting, limitation of visits, institutional protocols for PPE use, staff training) [16].

Our findings showed that women's knowledge, attitudes, and precautions taken in LWM in the context of COVID-19 were higher and better than males. The female's knowledge, attitudes, and practice scores against males were 45.6% vs. 10.4%, 68.0% vs. 12.8%, and 57.2% vs. 16.8%. Thus, females were in a better situation in all three dimensions. This difference between males and females could be due to women's higher sense of responsibilities in the family, more specifically with the surrounding environment [17].

The highest participation rate was for people with a work experience of 1–5 years, with most being in younger ages. People in the age range of 18–30 years made up 44.0% of the participants. Increasing age was accompanied by a decreasing level of knowledge, which can be due to the limited use of Internet and social media to acquire information. This is similar to findings by [18], who worked in Al-Ahsa in 2021, but contrary to Woromogo et al. who worked in Yaoundé in 2019 and reported age range 30–45 years more likely to have satisfactory knowledge of solid biomedical waste management [19]. The greater participation of young people in the study might be due to their interest and familiarity with filling the electronic forms. Also, younger people with lower work experience are more inclined to participate in various job-related courses for the sake of improving their resume for employment.

These findings showed that those working in educational hospitals had higher knowledge, attitudes, and precautions about LWM than those working in the clinics. This is due to the greater susceptibility of employees working in the educational hospitals than the clinics and the more availability of waste management equipment [3]. The other reason is related to environmental health experts in educational hospitals. Also, LTs had a higher knowledge and attitudes about LWM than the other professions, but there was no significant difference between their levels of precaution. This may be related to the lack of Laboratory background for waste management by the nurses, doctors and RTs. Education is an influential factor in health-promotion behaviours, and employees with a Diploma (MLT) had better LWM. Considering that average scores of knowledge, attitudes, and precautions at Bachelor's vs. master's degrees, were 12.4% vs. 1.6% (for knowledge) 14.4%

vs. 2.4% (for attitudes) and 15.2% vs. 2.4% (for precautions) these two groups were not in a good position in all three aspects. This could be due to their lack of knowledge in Laboratory courses [1,4,5]. The Pearson correlation coefficient showed a strong positive relationship between the healthcare provider's knowledge and practice about LWM. It shows that participants who had a good knowledge of waste management also had a good practice; and those who had a good attitude toward LWM also had a good practice. In other words, knowledge and attitudes had significantly influenced LWM. This finding is consistent with [20], who concluded that such a higher knowledge is related to a positive attitudes and good practice about LWM. Comparatively, this can be an improvement while considering the publication by who carried out the evaluation of health care waste management systems in the same region in 2011 [21]. Nassar et al. from their research in 2021, showed that there is a significant change or improvement in knowledge of HCWs post-training compared to pre-training [22]. Thus regular trainings should be promoted to highlight their role in effective precaution by HCWs.

More than half of the staff considered waste management as a waste of time and added up that neither they nor their colleagues played any significant role in waste management. It can be concluded that the healthcare staff should be trained, sensitized to accept their role in waste management. In light of these findings, it is deemed necessary to hold training courses on waste management during pandemics and refreshing courses out of such periods. These courses should regularly assess the healthcare staff's knowledge, attitudes, and practice on LW management.

### Conformity of Laboratory Waste Management with the World Health Organization's Guidelines

Due to the threatening nature of the SARS-CoV-2 virus, different countries have taken different measures to manage the Laboratory generated waste during pandemics. BHD hospitals represent some healthcare providing centers in Cameroon, and how these hospitals manage LW is not unlike other healthcare centers. Thus, they are expected to have similar problems managing the generated waste. According to the results and field visits, the above-mentioned hospitals face several problems in waste management, especially during the COVID-19 pandemic. Due to the contagious nature of this virus and the possibility of its transmission through contaminated waste, exclusive collection bins were necessary. However, there were not always separate bins in the 13 selected health facilities to collect infectious waste and hazardous waste. It is known that waste segregation is crucial in LWM. A well-organized training and awareness-raising course can improve waste management. In our study, most of the HCWs (57.6%) always followed the Ministry of Public Health guidelines for LWM, and 61.2% of HCWs carried out the colour coding of containers during the disposal of LW according to the type of waste. Approximately 75.3% of HCWs always adhered to the infection control policies while treating COVID-19 patients. Although still to be improved on, these performances might give rise to encouragement, compared to some other health care providing systems in the world. In fact, a study performed in select small health care facilities in Bangalore indicated that 20% of nursing homes had a policy for healthcare waste management [23].

Every HCW must be informed on the proper handling, disinfecting and wearing of PPE. Our study generally showed that although good attitudes and practices/precautions scored above fifty percent, knowledge was less than fifty percent, showing that HCWs practice routinely, without a good knowledge of the

problem. Descriptive research was performed at tertiary care health facilities in the metropolitan city of Pakistan, in which the sociodemographic variable when associated with practices, were found to be statistically significant [24]. In our study, there was also a significant association between the level of knowledge and demographic characteristics such as educational qualification, gender, work experience, religion and residence. The impetuous COVID-19 situation changed healthcare systems, and the pandemic crisis forced many hospitals to reorganize their healthcare systems. However, we still highlight that WHO standards were still to be met, so training sessions should be offered regularly to prepare HCWs for such pandemics outbreaks in the future.

### Limitations

A proportion of 13/37 health facilities only were involved in our study. A larger number of facilities would have given us a deeper insight on the situation in Buea Health District.

### Conclusion

HCWs are frontline workers in the COVID-19 crisis; they present a greater risk of contamination due to their direct contact with patients and specimens. We found that slightly lower than half of the HCWs had good knowledge while a large proportion had favourable attitudes and slightly above half took good precaution regarding the proper handling of Laboratory waste, prevention of transmission and infection with diseases. The qualitative assessment revealed differences in the experience and awareness of HCWs across all professions. Most participants appreciated the importance of their role in infection control, surveillance, and monitoring of the ongoing safety of their patients and health facilities. In this study, COVID-19 LWM did not fully conform to WHO guidelines at the Buea Health District. The present findings should help prepare for other cases of pandemics.

### What is already Known on this Topic

- Laboratory activity generates waste, and the management of laboratory waste is a precondition for the mitigation of the contamination of Laboratory workers and the environment at large due to laboratory waste.
- Pandemics generally increase the risk of contamination of Health Care workers.
- WHO has proposed guidelines for optimal laboratory waste management.

### What this Study Adds

- The proportion of HCWs who had good level of knowledge, good attitude and precautions in LWM were 48.4%, 84.8% and 65.0% respectively in Buea Health District.
- WHO standards were not strictly adhered to in the Buea Health District during COVID-19 pandemic.
- There is a need to make regular training programs in our hospitals, not only for laboratory workers, but for Health Care Workers in general, so that they will improve knowledge and easily practice in case of any new pandemic, while also training the hospital visitors.

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### Conflict of Interest

Authors declared they have no conflicts of interest.

### Authors' Contributions

Conception and design of the experiments: OSMB, JT. Data acquisition: DA. Data Analyses: DA, DCB, JT. Writing of the paper: OSMB. Proof-reading of the paper: OSMB, DCB. All authors read and approved the final manuscript.

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