

Supplementary Materials 1: Field on-site collection of data

A.1 Inventory Analysis

Measurements were made using a digital weighing scale with upper limit of 120 kg. Plastic bins for the collection of waste were used, having 2 kg of weight and 10-50 liters of volume. Waste production rate can be expressed either in kilograms per day or kg per year. This inventory collected the data of daily solid waste production (expressed in kg/day) and assessed its percentage composition according to a fixed classification system.

A waste list was defined on the basis of sampled HSW in the study area. Types of generated waste were identified by site through specific questionnaires, where the following details were recorded: demographic information; hospitalization; knowledge of waste types; assessment of medical waste management; information given by waste management personnel and according to the hospital waste management policies.

It must be noticed that, with respect to waste generation, separation, collection, storing and transportation for final disposal in the study area, no current waste management policy is applied. For this purpose, interviews are arranged with laboratory workers and officials, sanitary employees and nurses to assess the level of staff training. For this purpose, at each hospital randomly selected doctor's laboratory workers and officials, nurses, other worker, cleaners are addressed to questions mainly based on staff number in each selected hospital. Methodology used to conduct interviews was described by Longe and Williams (2006). It includes three instruments: survey questionnaire; site visit; in-depth interviews.

A.2 Questionnaire surveys and field investigations

Data about practices of HWM in the selected hospitals was mainly obtained from superintendents, health officers, nurses, and occupational through one to one interview and questionnaire surveys. Selected people were chosen, being responsible for HSW management within their hospitals. Onsite field investigations and direct assessment were also carried out at all selected hospitals. Generated waste flows were monitored along all collection, treatment and disposal phases during field surveys. These steps served to prepare the design of the subsequent study phases.

Waste separation and capacities measurement in each hospital was done next to engagements with particular public health related officers and other professionals. In this way, all waste generated during the days of survey were not collected prior to measure. Waste weight were conducted, accordingly, on a daily basis. Two or three measures were conducted, usually just before 8.00 am, prior to waste collection. In some cases, HSW was not differentiated, but mixed. In such a case, sorting was performed before measure. One type of waste was dominant in other cases. So, the less dominant type of waste was assumed to be ignore. Generated waste monitoring was also performed for nurse's sections, pharmacy centers and cafeterias. All this process was carried out due to ensure a complete range of causes and categories for wastes for each selected hospital. To ensure the accuracy in the results all the measurement procedure was repeated. The method for assessment of weight was performed as;

$$W_G = \Sigma (W_B)/W_T/p \text{ [Kg/P for per day]} \quad (1)$$

- The weighing balance was used to determine the weight (W_B) of vacant container.
- To avoid the vacant space in the container it is done by filling the containers with waste samples with constantly shacking.

- Weight balance was used to determine the gross weight (W_T) of containers/bins and waste.
- To determine the contribution of average patient (p) number to the waste generated in each hospital on the waste measurement time (t).

For the data analysis Statistical Package for Social Sciences (SPSS 2.0 version) software have been used. For determination of the significance level of association among variables at 95% level of confidence (sampling error $\pm 5\%$) the Chi-Square statistical test was done. The significance level was set at $p \leq 0.05$. For the sample of waste measurement, the above method has been followed for on each sample collection day and also various waste sources throughout the whole study period. (W_G) was calculated for the waste generation rate of per patient per day.

A.3 Ethical consideration and participants consent

From Lagos State Ministry of Health moral and ethical admiration have been obtain for this study. The approval from Health Research and Ethics Committee (HREC) was taken. Procedure for experiment was explained every participant and also their agreement to contribute were attained. Those who deteriorated and not to want be a part of the study was omitted. Privacy were guaranteed by barring names of each person in the surveyed hospital.

A total of 1000 healthcare workers, belonging to different fields, administered validated questionnaires. Out of them, 660 questionnaires were collected. As a further inclusion criterion, for only those who worked at least for one full year in the for-government hospitals, while for private sector hospitals only six months was taken in consideration for those who worked in the hospitals and admitted as participant in the study. Moreover, they had to work in any of the following areas: medical, surgical, surgery/gynecology, neonatology/pediatrics, wards, the theater, intensive care unit, blood bank/hematology, laboratories concerned with histopathology chemical pathology, bacteriology/parasitology, HIV units, compounding/dispensing pharmacies and waste handling. The study participants ($n = 641$) consisted of 102 numbers of doctors, 31 pharmacy related persons, 39 laboratory technicians, 161 nurses and 21 persons of waste collectors engaged government hospitals, and for private hospital doctors contribute 79 numbers, pharmacy related persons 19, laboratory technicians 29, nurses 140, waste collectors 20.

This part of the study implied a three-stage strategy:

1. The procedures, policies and rules set by the centers have becoming used to with the concerned management of the hospitals in the center where the waste is generated.
2. For the recording and writing of observations, need to spend sufficient time in many departments in crucial and serious manner for the medical wastes practices and this will be done by the concerned employees or management.
3. For the disposal, collection, treatment, transportation and segregation the questionnaires were distributed to evaluate the HWM which is based on subsequent the recommendation from WHO.

With the help of skilled officer and along with their direction the following steps were carried out to report consistent outcomes and assumptions concerning the degree to which the medical waste is controlled or pick up in such hospitals in terms of established international standards in this regard and written policies (WHO, 1999).

Besides direct knowledge on treatment plants and related engineering data, material inflows and outflows for the given treatment processes were determined on the basis of previous studies (Hong et al., 2018; Soares et al., 2013; Ali et al., 2016; Zhu et al., 2008; Zhang et al., 2003; Lee et al., 2002; 2004).

Supplementary Materials 2

Table 1. Hospital waste generation (kg/day) in Lower Swat, Khyber Pakhtunkhwa, Pakistan.

S.NO	Hospital	General waste	Infectious waste	Pharmaceutical waste	Sharp waste	Chemical waste	Pathological waste
1	Barikot Hospital GH ^a	10kg/day	4kg/day	10kg/day	15kg/day	8kg/day	3kg/day
2	Kabal Hospital GH	4kg/day	6 kg/day	8 kg/day	13kg/day	5kg/day	3 kg/day
3	Central Hospital GH	110kg/day	50 kg/day	130 kg/day	190kg/day	80 kg/day	40 kg/day
4	Saidu Hospital GH	27kg/day	16kg/day	42kg/day	50kg/day	30kg/day	26kg/day
5	Shifa Hospital PH ^b	20kg/day	10 kg/day	30 kg/day	40kg/day	10 kg/day	13 kg/day
6	Swat Medical Complex PH	50kg/day	25 kg/day	51 kg/day	80kg/day	20 kg/day	20 kg/day

^a Government Hospital

^b Private Hospital

Table S2. Hospital waste generation (kg/day) in upper Swat, Khyber Pakhtunkhwa, Pakistan

S. No	Hospital names	Types and amount of waste generated in selected hospitals					
		Pathologic al	Shar p	Pharmaceutic al	Gener al Waste	Infectiou s Waste and Potentiall y Infective Waste	Chemic al waste
1	Zakirshahe d Matta GH ^a	10 kg	25 kg	50 kg	60 kg	10 kg	5 kg
2	Hamdard Medical Complex Matta PH ^b	1 kg	2 kg	2 kg	2 kg	1 kg	1 kg
3	Hospital Khwazakhe la GH	5 kg	10 kg	15 kg	36 kg	5 kg	4 kg
4	Gull Medical Center Khwazakhe la PH	Null	2 kg	3 kg	4 kg	Null	Null
5	Civil Hospital Madyan GH	5 kg	10 kg	6 kg	10 kg	2 kg	2 kg
6	Hamid medical complex Madyan PH	Null	2 kg	2 kg	4 kg	Null	Null

a Government

Hospital

b Private hospital