

## Medical Waste Management Practices in North Eastern Free State, South Africa

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**ABSTRACT** This paper presents a study undertaken to investigate the state of medical waste management practices in different hospitals in the north eastern Free State Province, South Africa. A random sample of ten (10) hospitals was selected. A stratified random sample of 138 staff members spread across the ten medical facilities was selected and face-to-face interviews were conducted. Observation of operations was carried out over a period of six months. Data collection through observation and interviews covered waste generation, storage, handling, transportation, treatment and management procedures. Data analysis made use of SPSS to generate descriptive statistics, correlations and hypothesis testing. The findings reveal that medical personnel do not treat medical waste as specified in official guidelines, there is no formal training for personnel, medical waste is not a key priority, low levels of environmental awareness, inappropriate treatment of waste at some sites, and inadequate budget allocations for medical waste management. These findings indicate that there is an urgent need for addressing issues of awareness for managers, better on-the job training for personnel, better systems for on-ward conveyance of waste from facilities to official medical waste treatment plants, an up-grade of existing incinerators and the enforcement of procedures for waste data collection.

### INTRODUCTION

There is a general trend for growth to occur in the total quantity of wastes that are generated by medical activities in developing countries (Titto et al. 2012). This growth is due to a significant increase in the delivery of medical services, as well as an increase in packaging and in the utilization of single use items in the medical field. For public health reasons all wastes that have come into contact with infectious materials are treated as infectious wastes. Since most medical facilities in developing countries do not adequately segregate infectious or hazardous waste from ordinary domestic type waste, the total

quantity of waste classified as infectious and thus needing special treatment is greater than would be expected from the increase in medical waste alone (Achillas et al. 2013; Manga et al. 2011; Özkan 2013). From a sustainable health perspective, the priorities are based on providing affordable, accessible, safe healthcare to the whole population. Medical waste management is a fundamental strategic function in safe and responsible healthcare and is actively addressed by various bodies such as WHO, UNICEF and USAID. In South Africa, the poor level of medical waste management had already been identified by the national government (DOH 1996). A process of transformation of waste management has been initiated separately through a National Waste Management Strategy (DEAT 1999). In that respect, medical waste incineration has been identified as a potential cost-effective method for healthcare waste treatment.

Regulations governing emissions from large commercial medical waste incinerators (MWIs) are stipulated in South Africa (DEAT 2004). A less stringent set of performance criteria for the

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operation of MWI's at primary healthcare clinics has been under consideration by the DEAT, following the approach of WHO *TechNet* and UNICEF *Kazakhstan*. Firstly, the focus was put on the quantitative analyses of different incinerators in controlled laboratory conditions with identical waste loads. Secondly, qualitative and quantitative analyses of the performance of the incinerators during their use at actual clinics, with guidelines on waste loading procedures, but with no changes to current waste management practices (such as waste streaming and contents of loads) were carried out. Thirdly, it was necessary to seek acceptance of the regulatory stakeholders by evaluating the performance of the incinerators for each individual clinic site in the trials. This process also indicates the role that these kinds of incinerators play in the management of medical waste in rural primary medical clinics. Finally, the only objective of the trials was to present the DOH with specification guidelines and information upon which a tender specification could be formulated by the national department for the procurement of small-scale medical waste incinerators for use at rural primary medical clinics.

Medical waste creates serious threats to environmental health because it contains hazardous substances (Manga et al. 2011). These include pathological and infectious material, sharps, and chemical wastes. In hospitals, different kinds of therapeutic procedures are carried out and result in the production of infectious wastes, sharp objects, radioactive wastes and chemical materials (Hossain et al. 2013). Medical waste may carry germs of diseases such as hepatitis B and AIDS (Botelho 2012). In developing countries, medical waste has not received much attention and it is disposed of together with domestic waste (Titto et al. 2012). Many problematic waste management issues have been identified for healthcare clinics in South African rural areas and under-serviced areas in other parts of the world (Agamuthu 2013; Haylamicheal and Desalegne 2012; Hossain et al. 2011).

Outside the main towns, medical facilities in the north eastern Free State are in a typical rural setting. Several studies (Agamuthu 2013; Basu et al. 2012; Fadipe et al. 2012; Forouhar and Hristovski 2012; Murphy et al. 2011) have noted that the location and remoteness of medical facilities is a cause of concern for the various procedures

that could be carried in them; particularly with regard to medical waste management practices. The nature and quantity of medical waste generated as well as the institutional practices with regards to sustainable methods poorly examined and documented in South Africa's medical institutions. These are the health risks posed by improper handling of medical waste. The main purpose of the study was to investigate the status and management practices of medical waste at the health facilities in the north eastern Free State.

### Objectives

Several objectives were advanced: (i) to describe the current state of operational procedures with regard to the handling of medical waste (ii) to analyse the elements of the medical waste chain thereof (iii) to compare operations against official standards for handling medical waste (iv) to identify critical technical and managerial limitations in the delivery of an efficient medical waste handling program. It was hypothesized that the monthly volume of medical waste generated depends on the size of the facility in terms of hospital beds.

### MATERIAL AND METHODS

The study area is the north Eastern Free State forming part of the Free State, one of the nine provinces of South Africa (Fig. 1) while the distribution the interviews in the medical facilities are presented in Table 1. According to DEAT (2005: 12), there are 50 public hospitals with 10 016 bed capacity and 21 non-public hospitals with 1 951 bed capacity that produce 807 856 kg/annum and 618 116 kg/annum waste respectively. This represents 14% of the population of hospitals in the province.

The research design was centred on field surveys made up of site observations and measurement. Two instruments, a structured interview and an observation schedule were designed for this study. A pilot survey was initially also carried out in Phuthaditjhaba to test the suitability of the interview. The interviews were designed in such a way as to enable respondents to indicate waste types generated and disposal methods. The interview was structured to generate data on: sources of waste in the hospital, type of waste collected and handled, safety of personnel and personnel handling waste, ade-

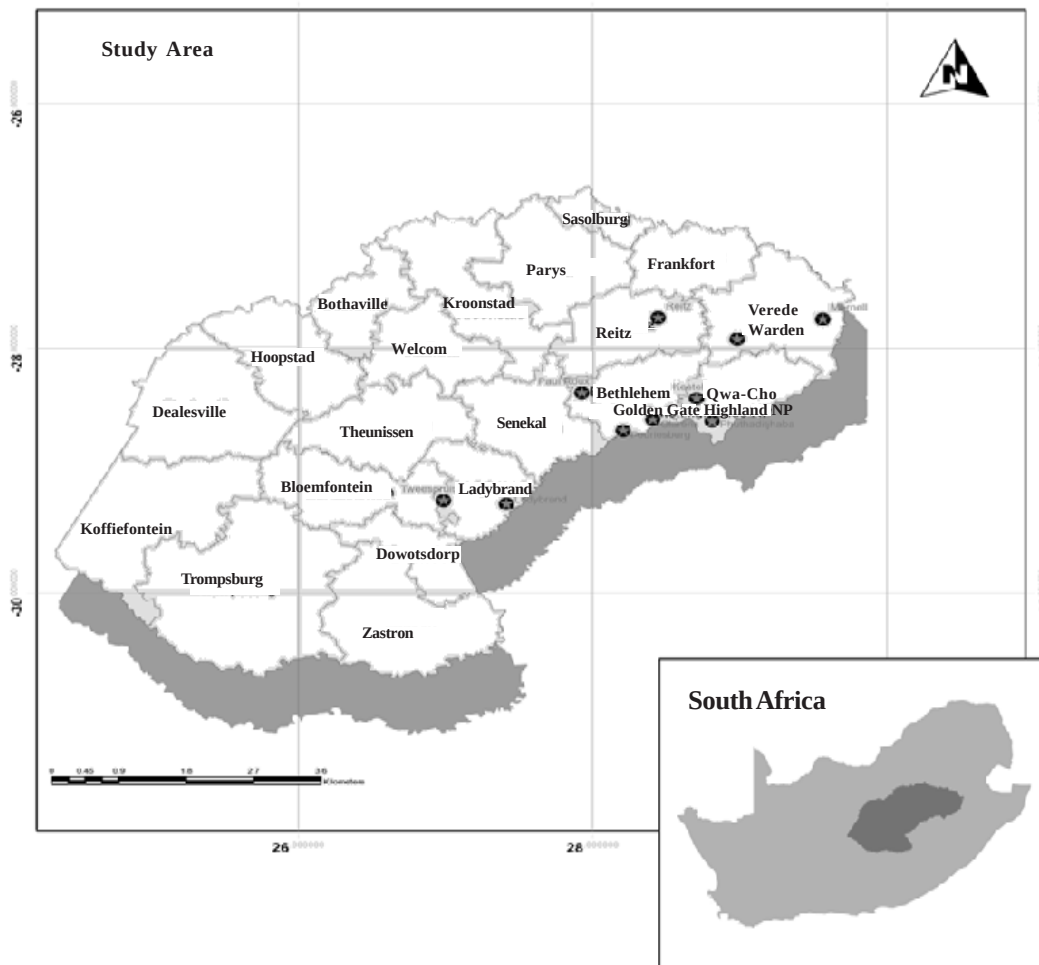


Fig. 1. The map of the Free State

quacy of the protective clothing provided, waste handling methods and procedures, transportation, treatment, and waste disposal procedures, existing waste management systems and the extent of awareness of hospital staff with reference to waste management. The existing medical waste management practices and policy with respect to collection, storage, transportation and final disposal were evaluated against health guidelines. Information regarding staff strength, quantities and waste types produced, services available, number of beds, average bed occupancy rate, and profile of medical waste handlers were collected through interviews.

The criteria used for classifying waste management practices included items such as: using a colour-coded container for segregation of medical waste; appropriate use of colour-coded containers for segregation; quality of on-site transportation of medical waste; use of safety boxes for sharp waste; use of protective clothing by medical waste workers; training of medical waste workers; method and quality of on-site treatment and; final treatment quality and disposal method. With reference to the state of operational procedures, collection of data in this regard was done by direct observation as to how waste was handled at each of the facilities visit-

ed. Other data on the current state of operational procedures with regard to the handling of medical waste was obtained from official reports of the Provincial Department of Public Health in Bloemfontein, supplemented by Annual Health Reports of Districts and Local Municipalities in the study area. In respect of the elements of medical waste chain, data was collected by the use of direct observation in order to identify elements of medical waste chain in each of the facilities visited.

This was followed by the administration of interviews with health officials in a selection of ten hospitals in the north eastern Free State. This was reinforced with secondary data from official sources at the provincial and national levels. The first level of respondents was made up of doctors, nurses, and hospital staff with waste handling. The second level of respondents were management officials at hospitals authority, medical service providers as well as all the relevant institutes and organizations involved in health care services. This interview was designed to suite four categories of personnel associated with medical care facility settings-shown in Table 1. In total, 138 medical personnel were interviewed. An observation schedule was used to capture the characteristics, volumes and movement of waste from generation to final disposal. Part of the information on the schedule was carried forward for use in objective (iii). The rest of the information was presented in the form of tables and descriptive statistics generated using Excel program.

Quantification of current operations against standards for handling medical waste was done using data from observations. Descriptive sta-

tistics were carried out to compute means and standard deviations showing the extent of clustering and dispersal. Computer generated graphics were used to show differences in trends between performance and expected standards. The SPSS statistical package (Microsoft 2012) was applied after specifying a confidence level of 95 percent. The conduct of a one-sample t-test was based on the rule for rejection of the null hypothesis: Reject  $H_0$  if  $p > 0.05$ . The results showed the nature, direction and strength of interactions between critical variables in the medical waste handling chain. Data on critical technical and managerial limitations was collected using the interviews coupled with direct observation of medical waste handling procedures at each of the facilities. Information obtained here was used to identify critical technical and managerial limitations in the delivery of an efficient medical waste handling program. Outputs of these computations are reported in the results section of the study and some are carried forward into hypothesis testing. Using results from objectives 1, 2 and 3, a set of limitations were extracted for further use in the discussion section of the study. This was done to focus on the potential problems posed by the disposal of hospital waste.

## RESULTS

### Status of Medical Waste Management Practices

In terms of gender composition of respondents, males and females accounted for 61 and 39 percent respectively. On the awareness of

**Table 1: Distributions of interviews**

| MunicipalityHospitals |                    | Respondents |       |         |              |                        |                | Total |
|-----------------------|--------------------|-------------|-------|---------|--------------|------------------------|----------------|-------|
|                       |                    | HOS*        | HOD** | Doctors | Pharma-cists | Laboratory supervisors | Waste handlers |       |
| Maluti-A-Phofung      | Mofumahadi Mmanapo | 2           | 8     | 16      | 4            | 4                      | 4              | 38    |
|                       | Elizabeth Ross     | 1           | 3     | 2       | 1            | 1                      | 1              | 9     |
|                       | Thebe              | 1           | 3     | 6       | 2            | 1                      | 1              | 14    |
| Dihlabeng             | Dihlabeng          | 1           | 6     | 10      | 2            | 1                      | 1              | 21    |
|                       | Medi-Clinic        | 1           | 3     | 7       | 2            | 1                      | 1              | 15    |
|                       | Phekolong          | 1           | 3     | 6       | 2            | 1                      | 1              | 14    |
|                       | Corona             | 1           | 1     | 1       | 1            | 1                      | 0              | 5     |
| Nkhono Mantsopa       | Nkhono Mantsopa    | 1           | 4     | 2       | 1            | 1                      | 1              | 10    |
| Nketoana              | Nketoana           | 1           | 1     | 2       | 1            | 1                      | 0              | 6     |
| Phumelela             | Phumelela          | 1           | 1     | 2       | 1            | 1                      | 0              | 6     |
| Total                 |                    |             |       |         |              |                        |                | 138   |

Where, \*HOH = Head of Health, \*\*HOD = Head of Department

any legislation relating to hospital waste management, 77.5 percent of the respondents reported that they were not aware of any legislation relating to hospital waste management while 22.5 percent indicated that they were aware of such legislation. Of these respondents who were at least aware of the legislation governing hospital waste management, 15.9 percent correctly mentioned that the relevant legislation is the National Environmental Management Act (NEMA) (DEAT 2007), 6.5 percent could not say which piece of legislation they were referring to and 77.5 percent did not comment. When asked about the availability of a waste management plan in their medical facilities, 71 percent indicated that there was no such a plan while 29 percent indicated that there was a waste management plan in place at their medical facility. When asked about whether waste should be segregated, the responses were 79 percent in disagreement and 21 percent of the respondents in affirmative. The results obtained for waste disposal methods reported incineration, containment and segregation in the order of 47.8, 30.4 and 21 percent respectively. Results showed that 79 percent of the respondents did not know who did the segregation while 13.8 percent said that it was done by supervisors, 5.8 percent indicated that it was done by medical waste handlers and 1.4 percent by medical doctors. With respect to colour-coding waste for disposal, 89.9 percent responded in affirmative while 10.1 percent were not. The colour-coding was appropriately matched by those who did it such that the scores for matching red was 5.1; yellow was 4.3, black was 2.9 percent respectively while 87.7 percent did not. Disposal of medical waste was in the order of 89.1, 5.8 and 5.1 percent respectively for collection, dumping into municipal bin and use of any other authorized waste collectors respectively. The absence of a waste register was confirmed by 97.8 percent of medical facilities in the study area. All facilities reported they had no audit in the last three years prior to the conduct of this study. Regarding respondents having undergone training on medical waste management and or the provision of on-site education on waste management to employees, 78.3 percent were eager to attend any relevant training programme while 21.7 percent showed no interest. At the facility level, for the respondents who reported color-coded waste for disposal, segregation was done by 26.7 percent; containment

was done by 9.5 percent and incineration was carried out by 3.0 percent. For those facilities which practiced incineration, 50.0 percent could match waste relevant to yellow while of the respondents who segregated medical waste, 38.5 percent could match waste relevant to yellow. None of the respondents who practiced containment could match waste relevant to yellow. Red was matched by all those who practiced containment, 50.0 percent by those who incinerated and 30.8 percent by those who segregated.

Only 30.8 percent of those who segregated correctly matched black. It was shown that of the respondents who labeled the bio-hazard symbol for waste for disposal, 9.5 percent favoured containment, 6.7 percent segregation and 6.1 percent incinerated while respondents who did not label infectious waste with the bio-hazard symbol for each of the disposal methods were in excess of 90 percent. Of those who kept a waste register, 10 percent of the respondents segregated waste for disposal. The results show that of those who dumped waste into a municipal bin, 10 percent also segregated waste for disposal, 9.5 percent practiced containment and 1.5 percent incinerated. Nearly 90 percent of the respondents indicated that each department is responsible for collecting its waste irrespective of the final disposal method.

The results further show that incineration was favoured by 7.6 percent of the respondents, who also felt waste, could be collected by any other authorized waste collector; containment was favoured by 4.8 percent of the respondents and none favoured segregation. At the level of individual facilities, the results indicate that at regional hospitals, 21.1 percent of respondents were aware of waste management legislation. At the district and other specialized hospitals, the scores stood at 20.6 percent and 28.1 percent for those who were aware. The presence of a waste management plan was confirmed by 36.8, 20.6 and 37.5 percent respectively for regional hospitals, district hospitals and at other specialized hospitals.

At district hospital level, 79.4 percent of respondents could not confirm the presence of waste management plans while at specialized hospitals the score came to 62.5 percent. In all health settings, it was found that no authorization and attachment of waste management was done to any job description. On the basis of these results, the first objective of this study

which was to describe the current state of operational procedures at a selection of medical facilities has been addressed.

Direct observation carried out at individual health facilities showed that hazardous waste was not segregated from municipal general waste (MGW) at source. Several inappropriate procedures were observed: both types of waste were collected in common municipal bins, the sharps' containers were in some instances more than 75% full with sharps, blood-soaked swabs were found in municipal bins and medical waste was collected and casually carried by hand amidst patients and visitors and not on wheeled trolleys. It was observed also that often no proper protective gear was regularly supplied, no proper containers and or appropriate bio-hazard symbols. At one of the regional facilities, waste is dumped together irrespective of the nature of the waste. Sometimes temporary storage facilities were observed to be overfilled and waste was just left outside the storage facility. This particular storage facility was not locked even where the sharps' containers were temporarily stored. No clear indication of when the off-site transport would clear the storage was given, indicating a possibility of medical waste over-staying at the central temporary storage. At regional hospitals, the medical waste chain can be such that little or no segregation was done at the source. Waste was collected at a central storage facility to await off-site transportation by a privately sourced company. In some instances, medical waste was incinerated on-site at a nearby incineration plant. At district hospitals, most waste was actually incinerated on-site. Deep burial was observed as a common practice for special and other smaller medical facilities.

### Operating Standards

Results from the conduct of a t-test on the three health settings, using "Central" as the control appears in Table 2. The last column shows the mean per capita volume of waste per patient

per day. The ranking of the health facilities in terms of the number of beds is in the order of: (i) regional, (ii) district, (iii) central, and (iv) special. A comparison of the results shows that the size of the facility does not appear to be related to the mean volume of medical waste generated. Regional scores a value of 0.55, district scores 0.79, special scores 0.08 while the control scores, the highest at 1.42.

In Tables 2 and 3, average rates are compared to standardise rates and in Table 4, confidence intervals are presented. The *t*-statistic and the *p*-value are shown for each category of medical facility. The *p*-value shows the significance of the statistical relationship between volume of waste generated and the number of hospital beds. The rule for rejection of the null hypothesis was: Reject  $H_0$  if  $p > 0.05$ .

**Table 3: One sample t-test: Average rates compared to standardised rates**

| Hospital | <i>t</i> -statistic | <i>p</i> -value |
|----------|---------------------|-----------------|
| Regional | 11.677              | 0.000           |
| District | 52.351              | 0.000           |
| Central  | 3.627               | 0.001           |
| Special  | 50.461              | 0.000           |

The *p*-value scores in Table 3 indicates that all fall below the cut off ceiling of 0.05. It follows therefore that there is no statistically significant relationship between the volume of medical waste generated and the number of hospital beds. The null hypothesis is therefore accepted. The *p*-value is 0.000 which is less than 0.05 and this means that the amount of waste gener-

**Table 4: Confidence interval of the difference**

| Hospital | 95%   |       |
|----------|-------|-------|
|          | Lower | Upper |
| Regional | 0.640 | 0.925 |
| District | 0.652 | 0.704 |
| Central  | 0.020 | 0.070 |
| Special  | 1.565 | 1.704 |

**Table 2: Statistics - Average rates**

| Hospital | <i>n</i> | Mean  | Mean difference | Standard rate |
|----------|----------|-------|-----------------|---------------|
| Regional | 30       | 1.337 | 0.787           | 0.55          |
| District | 60       | 1.468 | 0.678           | 0.79          |
| Central  | 45       | 1.465 | 0.045           | 1.42          |
| Special  | 15       | 1.715 | 1.635           | 0.08          |



ated at specialised hospitals is different from the standards value of 0.08. It is actually higher than the standard rate, the difference is 1.635.

Analysis has shown differences between the facilities in terms of the volume of waste generated and the size of the facility. It has been shown, as expected, that the larger facilities generate more waste, requiring higher cost overheads. In this regard, objective 3 which called for a comparison of performance differences across the facilities in the study area has been addressed.

### Limitations in Waste Handling

One major limitation noted in this study is the lack of training in effective waste management techniques. Of the 138 respondents interviewed, 12.3 percent of the respondents were heads of departments, 11.6 percent were supervisors and 76.1 percent were pharmacists. The education level varied widely and consistently showed no relevance for waste management practice. All respondents were also not aware of any authorisation requirements relating to waste handling. Results on attitude assessment showed that the safe management of medical waste was not a priority by 75.4 percent respondents. At least 18.1 percent agreed that it should be an issue while the rest made no comment. At least 76.8 percent of respondents saw safe waste management as the responsibility of government. Safe waste management was also perceived as an extra burden on work by all respondents. With regard to health facilities, attitude levels differed in that safe waste management was not important for 44.7 percent of respondents at regional, 80.9 percent at district and 100 percent at specialised hospitals. Responses showed a more or less similar pattern with reference to whether safe waste management put an extra financial burden on management and an extra burden on work.

### Hypothesis Testing

Pearson's correlation coefficients were computed to trace the possibility of a relationship between the tested variables. The pairs of variables tested were: (i) volume of medical waste generated and the size of the medical facility and, (ii) the volume of medical waste generated and the frequency of incineration. On comparing the  $p$ -value to a significance level of 0.05 (5%), it was less than 0.05 showing a significant

correlation between the variables. On comparing between volume of waste generated and size of the facility, if the calculated value is significant it would call for regression analysis but it was not the case. The  $p$ -value is 0.152 which is greater than 0.05. This means that there is no significant relationship between amount of waste generated and size of facility. Current medical waste management practices which include waste sorting and segregation, practiced in large and specialized medical facilities to some extent, have aided substantial reductions in what would otherwise eventually end up in the waste stream. This is because no pro-active recycling of waste materials is employed.

## DISCUSSION

### State of Operational Procedures

The study has established that operational practices of medical facilities in the area do not have a definite medical waste management policy. It was observed that there appeared to be no clear policy in place for managing medical waste. Yet, the Medical Research Council (MRC) and the Department of Environmental Affairs (DEA) have had guidelines on the handling of medical waste for several years. Whether such guidelines are made available to local managers at medical facilities is a different matter. There is no definite policy or plan for purchasing the necessary equipment and for providing the facilities with the correct management of medical waste. Most facilities have medical management guidelines prepared by supervisors but these are not strictly followed. Segregation was considered a secondary objective in the Department of Health and is perceived as time-consuming. Inappropriate on-site conveyance of medical waste is considered a remedial measure to minimize accumulation at points of generation and enhance or promote a clean working environment-but the risks associated with it are not appreciated. Similar findings are reported in Oroei et al. (2014) for Shiraz, Iran and in Olukanni et al. (2014) for Nigeria- where most practices were not in line with prescribed standards. From these findings, it would appear that the inspectorate division of the DOH at the district and provincial levels has not been particularly vigilant in ensuring adherence to official national guidelines.

The main problems identified during the interviews are: lack of necessary rules, regulations

and instructions on the different aspects of collections and disposal of waste; mixing of different types of waste, inability to use different designated colour-coded bags, absence of dedicated waste managers and, absence of team responsible for monitoring medical waste management practices. These inherent limitations may however be far widespread across medical facilities and beyond the borders of the province. They point to serious managerial problems at the institutional level- a finding also reported in Ruhiiga (2013) and in Mudau et al. (2013) and to provincial competences in the context of enforcement of environmental regulations. The enforcement of medical waste handling guidelines requires the recruitment and employment of appropriately trained staff. This is difficult to achieve because locally few institutions provide training in environmental health. The results show shortcomings similar to those noted in other studies elsewhere (Aghapour et al. 2013; Alavi et al. 2013; Nguyen et al. 2014). They also reveal the seriousness with which current operations have to be viewed (Hossain et al. 2012; Johnson et al. 2013; Kinnarinen et al. 2013) and that the problem is not unique to any particular location

### **Elements of the Medical Waste Chain**

With reference to the medical waste management chain, large and specialized medical facilities had better knowledge about the nature, management system and characterization of medical waste. Results showed that medical waste is not adequately sorted in any of the facilities in the study area. Segregation was generally not perceived as a vital component of medical waste handling, a finding that concurs with Nguyen et al. (2014) on Hanoi City, Vietnam before the waste balance is conveyed to incinerators and landfills. The role of sustainable waste management is to reduce the amount of waste that is discharged into the environment by reducing the amount of waste generated. Improper waste management and disposal practices pose threats to those living in nearby communities and can result in costly clean-ups.

### **Comparison of Operations and Official Standards**

In general, waste management practices in the study area are not compliant with existing national guidelines on medical waste. Observa-

tion of the waste chain at various facilities generated results which confirm this conclusion. The same is true from responses of officials at these facilities. This cuts across waste storage, handling, collection, transportation and disposal practices. Waste are collected at the point of generation into metal dustbins, drums, plastic bins, baskets, pans, cartons and buckets before transfer into larger or final disposal containers. Waste handlers in some facilities carry waste on shoulders or bare hands which indicates lack of awareness about potential risks involved. In contrast, large and specialised medical facilities offer pushcarts as well as wheeled plastic bins, to facilitate easier and safer waste transfer. Disposal of most medical waste is unregulated and dealt with in a haphazard manner. Observations at some medical facilities revealed that hygienic and technical considerations were neglected. Such findings are not unique however, for, Pawan et al. (2014) report shocking low levels of awareness of bio-medical waste by health workers at a tertiary hospital in India.

The use of trained and knowledgeable personnel (Kishore et al. 2014) is central in waste management. Training of both the technical staff and the non-technical staff is critical for the proper and appropriate management of medical waste. Unfortunately, laxity and lack of adequate training and awareness in the execution of these rules remains problematic. A significant proportion of hospital waste was handled by trained personnel in large and specialized medical facilities compared to smaller facilities. The management of infectious waste was found to be normally governed by largely untrained and illiterate waste handlers from poor backgrounds. A similar finding is echoed in Oroei et al. (2014) whose study in Shiraz, Iran found serious weaknesses in the training and supervision of staff. It was evident that that waste handlers are not effectively trained. Where some level of training has been done or given, such programs are not periodically updated. Most waste handlers in the study area are susceptible to hazards due to lack of protective gear. Similar findings are reported in Lakbala and Lakbala (2013), Mohan et al. (2012), Polan et al. (2013), Singh et al. (2012) and Umar et al. (2011).

### **Technical and Managerial Limitations**

Managerial and technical limitations included a lack of awareness of keeping records on waste generated and on waste segregation



practices. The increase in the waste generation ordinarily leads to an increase in the medical risk waste (MRW) which is often mixed with common general waste and disposed of as municipal waste. Concerning the issue of waste production, the volume of waste generated in hospitals depends upon various factors such as number of beds, types of health services provided, economic, social and cultural status of the patients and the general condition of the area where the hospital is situated. Results from interviews with waste management staff in the hospitals showed a persistent pattern in the failure to keep records of waste generated at the facility. The hospitals do not maintain records or registers of medical waste collected, stored or disposed of on a daily, weekly or even monthly basis. This has serious implications for measuring the technical and managerial efficiency of the waste system.

Most hospitals did not label infectious waste with the bio-hazard symbol. No control measures exist for the management of such waste. Separation of medical waste and general waste is however practiced to a satisfactory extent. From observations at medical facilities, it was not clear whether the problem could be located within supervision structures or simply the absence of an oversight on the part of managers. No facility, for example, reported labour shortage as a deterrent in ensuring better management practices. From the results, on-site transport of medical waste generated in the hospitals should be on a daily basis. Once collected, waste is transported to a temporary storage area by hospital staff. It is imperative for medical waste to be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. It is important to note that the lack of suitable and sufficient protective equipment, the lack of knowledge regarding the correct use of equipment and the lack of pertinent understanding of personnel regarding the benefits of using protective equipment exposes them to serious dangers. In terms of temporary storage, each facility was observed to have on site a cordoned-off storage area for medical waste. These areas are required to be well sanitized and secured in such a way that they should be accessible only to authorized persons. Most hospitals have a temporary collection site and variations only arouse as to the safety status of such areas. It was observed

during field work that in some cases it was left unlocked and movement into and out of this storage was unregulated. Medical waste treatment on site at the individual facility leads to a reduction in volume, weight, risk of infections and organic compounds of the waste (Farshad et al. 2014). During the interviews, it was indicated that incineration is the prime method for the treatment of medical waste especially infectious and sharp wastes for the hospital.

Off-site transport of medical waste is undertaken by private waste management companies and waste is transported in some cases weekly from large and specialized medical facilities while small medical facilities are faced with options of having to bury or incinerate at low temperatures on their premises. Note once again that this is against basic guidelines for medical waste management. Given that incinerators at these smaller facilities are not synchronized to deliver the same heating temperature levels as required by official guidelines, the practice of burying such waste poses long term environmental and health dangers. Ideally therefore, such facilities could make arrangements for medical waste to be transported to the nearest larger medical facilities where proper infrastructure for onward transmission to official hazardous waste dumps exist. There is no reason why, given that these are public institutions, the overhead costs involved in such an arrangement cannot be factored into their normal budgeting processes. Waste from most large hospitals is transported to an off-site area, which has been dedicated for this purpose on the other side smaller medical facilities often have to dispose medical waste using landfill sites.

The research findings in this study share the same sentiment with Idowu et al. (2013) that strict and correct implementation of advanced and improved medical waste management will require the involvement of accredited training centres to deliver the education and training required for staff (Pawan et al. 2014). It is also essential that these training sessions are not merely a one-off event for individuals, but that staff is enrolled in an on-going career-based learning process. The hospital authority should make these policies more easily accessible and visible, and strive to bring training in medical waste management to their doctors. Leadership in the medical institutions should invest more in people by training staff in MW segregation. Medical insti-

tutions should provide information in the form of posters and manuals in wards and units to inform staff and the public on good practices.

The attitude of personnel in larger and specialized facilities was better towards handling medical waste as compared to those in smaller facilities. The feeling that waste management is not an important issue could also be tied to monetary allocations because most facilities in the study area have budget constraints compared to performance expectations. This issue was frequently raised during the interviews as respondents elaborated on waste management policy. Respondents were more passionate about the professional roles citing under-staffing and referred to waste management as a supportive duty. Respondents were on the overall avoiding duties relating to waste management, citing lack of adequate personnel protection and, lack and/or inadequate compensation in events of accidents. The general perception was that even if medical waste was managed appropriately, there was no reward. Attendance of training programmes did not necessarily translate to promotion at work and upward progression. Regarding practices related to medical waste management, sanitary staff were ignorant on all the counts (Mathur et al. 2012; Nagaraju et al. 2013). New measures should be adopted to inform the public about legislation regarding medical waste management because the risks involved in waste sorting, recycling and resale are not appreciated. This may not be easy as often it is the illiterate and very poor people who are active in waste recycling (Jindal et al. 2012; Lakshmi and Kumar 2012; Narendra et al. 2013; Sharma et al. 2013).

### CONCLUSION

The methods of handling, transportation, storage, and disposal of wastes generated at the various medical facilities fall below the requirements as per national guidelines on medical waste. This study has noted generally poor methods of management, a lack of priority for medical waste management at the institutional level and the low level attached to medical waste management in the budgeting process. Problems of inadequate environmental awareness have been sighted, made worse by a blatant disregard for protocols across the board by those supposed to manage the system. The study

has indicated consistent problems of management linked to inadequate training of personnel, lack of in-built incentives for staff promotion and failure to adhere to official medical waste management guidelines. It has been shown that systems for on-site supervision of operations are poor and inadequate. There is lack of awareness of the need to keep records of waste generated and lack of awareness on waste segregation. Threats to both the environment and public health due to the poor handling and disposal of medical waste are noted. There are low and inadequate levels of control from the district and provincial departments of health. Even allowing for variations across the study area, there is a low level of appreciation of the dangers of medical waste. But these conditions cannot be only blamed on the individual medical facilities in the study area. It is true that the larger facilities perform better with respect to medical waste management but what this study reveals is management failure at higher levels of the medical bureaucracy. The district and the provincial DOH has to be held partly accountable for failing to ensure the control and regulation of medical waste management. Health workers, patients and the public are at high risk due to this poor management of medical waste.

### RECOMMENDATIONS

Four recommendations are advanced to create a platform for interventions aimed at improving the system: First, there is an urgent need for a better system of control and enforcement of best practice in medical waste management. This calls for the intervention of health authorities at the district, provincial and national level. In support of such a measure, the public health inspectorate should be developed and staffed with appropriately trained technical public health inspectors with the right to enforce applicable legislation. Second, it should be mandatory each for medical facility to ensure a safe and hygienic system of medical waste handling, segregation, collection, storage, transportation, treatment and disposal, with minimal risk to handlers, public health and the environment. Third, all staff and waste handlers in each medical facility should be regularly updated with in-house specialized training, which provides them with a knowledge base about the process of waste management and associated health risks. Finally, the Depart-

ment of Health should exercise greater and more active control and regulation over the management of medical waste.

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