



Recommendations through a Complete Study on Healthcare Solid Waste Management Practices of Government Hospitals in Colombo, Sri Lanka

Bandunee C. L. Athapattu^{1*}, A. P. Priyantha² and Masafumi Tateda³

¹Department of Civil Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka.

²Environmental Studies Unit, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka.

³Department of Environmental Engineering, Toyama Prefectural University, Toyama, Japan.

Authors' contributions

This work was carried out in collaboration between all authors. Authors APP and BCLA designed the study. Data collection and analysis were done by author APP with the guidance of author BCLA. Author BCLA wrote the first draft of the manuscript and taken care of formatting and provided finishing touch to this manuscript. Author MT managed the literature searches and analyzed data further and formatted in the present form. All authors contributed equally for this work and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2015/16828

Editor(s):

(1) Narayan Thapa, Department of Mathematics and Computer Science, Minot State University, 58707 Minot, ND, USA.

Reviewers:

(1) Anonymous, Harare Institute of Technology, Zimbabwe.

(2) Anonymous, Universidad Autónoma de Baja California, México.

(3) Anonymous, India.

(4) Abraham David, Morakinyo, Department of Industrial Design, Modibbo-Adama University of Technology, Yola, Adamawa State, Nigeria.

Complete Peer review History: <http://www.sciencedomain.org/review-history.php?iid=1127&id=22&aid=9218>

Original Research Article

Received 15th February 2015

Accepted 26th April 2015

Published 12th May 2015

ABSTRACT

Eighteen hospitals in Colombo, Sri Lanka were investigated in terms of understanding the current situation of healthcare management in the capital city of Sri Lanka. Questionnaires and investigations involving direct visit were done to obtain more concrete data. The study was carried out during January 2012 to December 2013. Out of studied hospitals, ten hospitals are being administrated by central government and the rest by the provincial governments. The focus of this study were the general information such as names and types of hospital selected for investigation, amount of waste generated, numbers of beds, etc.; waste types; sources of waste generated;

*Corresponding author: Email: bandunee@yahoo.com;

segregation of healthcare waste; waste storage, transportation, and disposal; and adherence to regulations stipulated by the central government. The results of this study revealed that most of the hospitals investigated were neither satisfactory in terms of World Health Organization (WHO) guidelines for waste disposal, nor on environmental grounds. Several recommendations were made based on information obtained through this study including healthcare waste management plan, training, and education in each hospital with respect to waste minimization, efficiency from waste segregation up to disposal, minimization of health risks and environmental pollution.

Keywords: Healthcare solid waste; hospital; storage; segregation; treatment; disposal; regulation.

1. INTRODUCTION

Healthcare wastes are defined to include all types of wastes produced by health facilities such as general hospitals, medical centers, and dispensaries. In 2012 comprehensive literature on healthcare waste was introduced by Blenkarn [1]. Healthcare wastes represent a small amount of total residues generated in a community. According to the records of Central Environmental Authority (CEA) Sri Lanka generation of the healthcare waste is about 5400 MT/year in 2014. Waste Management Authority in Western Province reported that out of total dumping waste 0.03% is treated healthcare waste which is currently dumped at Karadiyana dump site in Colombo District. However, such residues can potentially transmit infectious diseases and present an additional risk to the staff of the healthcare facilities, patients and the community when they are not managed properly [2,3]. Healthcare wastes may be classified into different types according to the source, type, and risk factors associated with their handling, storage, and ultimate disposal. Some studies were [4] investigated healthcare waste generation from different categories of healthcare facilities. Throughout the world, the health sector is developing and improving more rapidly compared to other economic sectors. However, it seems that the fraction of waste generated at healthcare institutions has not attracted the same level of attention as other types of wastes, particularly in developing countries, despite the fact that healthcare wastes are labeled as hazardous waste because they pose serious and direct threats to human health [5-15]. Healthcare waste poses serious threats not only to human health but also to economy of a country. An illicit economy based on healthcare waste has also been reported in some developing countries. It is even more serious when it is reported that due to inadequate storage facilities for hazardous waste scavengers were able to gain access to items such as syringes and expired medicines, which they repackaged and resold [16].

The healthcare service system in Sri Lanka can be divided into government and private hospitals. Governmental hospitals serve around 95% of the Sri Lankan population, and the private sector serves the rest 5%. The governmental service system in the country is divided into curative services and preventive services. Health care is provided free of cost to all people including the super specialty services. For preventive services, there is one Medical Officer of Health (MOH) in each Assistant Government Division (AGD), per 60,000 people. Each MOH is supported by Peripheral Health Mid Wives (PHMW) and Public Health Inspectors. They are responsible for the mother and child health programme and for the food hygiene and sanitation respectively. In each district, there is a Deputy Director Provincial Health officer (DDPHS); for each province, there is a Provincial Health Officer (PHO); and at the top of this hierarchy is the Director General of Health Services (DGHS). The number of private medical services is relatively small in Sri Lanka, and these services are predominantly located in Colombo and the other larger cities. Management of healthcare wastes is a major environmental issue in the country. Though healthcare services are responsible to manage healthcare wastes they generate, most of them fail to do this efficiently, which results in environmental pollution through such wastes.

This study aims at examining healthcare waste, especially hazardous waste such as pathologic, infectious, sharp objects and radioactive waste management practices by surveying the current practices followed by the government hospitals in the Colombo District. Colombo District was selected as the survey area because all hospitals in the district are government administered.

2. MATERIALS AND METHODS

2.1 Hospitals for Investigation

Eighteen out of 26 government hospitals in the Colombo District were selected in order to

characterize the healthcare wastes in the national context. Colombo District was selected as the survey area because it is the most important district in the country and has the most comprehensive healthcare centers in the country. Colombo is also the most populated, industrialized, urbanized, and developed district in the country based on the social and economic sectors. Additionally, the population in the district represents every ethnic group and every religious group in the country. The social framework of the district consists of municipal, urban, suburban, and rural areas. Municipal areas are with highest population density when compare to other areas. Generally district capital is considered as municipal area. Every type of government hospital is located within Colombo district. These include categories like national hospitals, general hospitals, teaching hospitals, base hospitals, district hospitals, peripheral, rural and other hospitals. National, general, base and other hospitals are administrated by the central government while base, district, peripheral, and rural hospitals are administrated by the provincial government. There is a national hospital in Colombo, which has all the specialty and super specialty services, and is the apex referral center in the health system. In each district, there is one general hospital with specialties like ENT (Ear, Nose and Throat) ophthalmology, dermatology, and radiology apart from medical, surgical/pediatrics and obstetrics and gynecology (OBG). Teaching hospitals are attached to the medical colleges. Base hospitals act as referral units with medical, surgical, pediatrics and obstetrics and gynecology specialties. Further, there are five to eight district hospitals in each district, depending on district size and population. For curative services, the government has established peripheral units (PU) in rural villages. Rural hospitals offer basic treatments.

2.2 Research Design

Research design for conducting this study consisted of four major tasks:

- i) Developing a questionnaire
- ii) Identifying the hospitals in the Colombo District to be visited for data collection
- iii) Conducting site visits to selected hospitals and collecting data and information through interviews and observations, and
- iv) Analyzing survey results to make recommendations regarding sound healthcare waste management in the government hospitals in the Colombo District.

2.3 Questionnaire Development

The questionnaire was developed based on the recommendations of the World Health Organization (WHO) for evaluation of hospital waste management in developing countries [10]. After taking into consideration specific differences which may exist in hospitals in Sri Lanka and the views of environmental specialists regarding the present problems in the management of medical waste and the expected results from the questionnaire, some modifications were made to the questionnaire suggested by the WHO. The questionnaires were divided into six sections:

- i) General information, such as names and types of hospitals selected for investigation, amount of waste generated, numbers of beds, and so on;
- ii) Waste types;
- iii) Sources of waste generated;
- iv) Segregation of healthcare waste;
- v) Waste storage, transportation, and disposal; and
- vi) Regulation adherence.

2.4 Site Visits

Authors made two to five visits to each of the selected hospitals. Five visits to the national and teaching hospitals, three visits to base hospitals and two visits to the rest were made during this study. Each visit consisted of spending time in the different departments of the hospital, recording notes and making observations about the healthcare waste management practices followed by staff responsible for the task. Regular visits were conducted to general medical wards, maternity wards, surgical and intensive care wards, operation theaters, and orthopedic sections, as well as waste collecting, treatment, and disposal areas. The authors collected information examining the rules, procedures, and regulations followed by the personnel regarding the management of medical waste generated at the hospital. During the visits, the authors were accompanied by one or two members of hospital staff, the head of the hospital, who is in charge of the infectious control unit, and a public health officer; in addition, two personnel engaged in waste management were interviewed for collecting data and information included in the questionnaire. Site visits were helpful in obtaining firsthand knowledge of handling and disposal practices of healthcare wastes.

2.5 Data Analysis

The analysis is essentially descriptive. Data for the analysis were extracted from questionnaires and personal interviews carried out by the authors.

3. RESULTS AND DISCUSSION

3.1 General Information

The collected data was analyzed explaining the present healthcare waste management practices adopted by the government healthcare establishments in the Colombo District. To analyze the data, the investigated hospitals were divided into Groups A and B, based on the following facts. The hospitals in Group A are administrated by the central government and available for specific treatment facilities of operation theaters, radiotherapy, testing laboratory, intensive care, blood bank, wards, and clinics. The hospitals in Group B are administrated by the provincial government and include an outpatient department, dental unit, isolation ward, wards, and clinics. General information on the selected hospitals is summarized in Table 1.

A total of 14 hospitals in Group A were located in Colombo and consisted of one national and general, nine teaching, one base, and three other

hospitals. Eight of the hospitals in Group A were investigated. On the other hand, a total of 12 hospitals from Group B exist in Colombo i.e., three base, three district, five peripheral unit, and one rural, out of which 10 hospitals were investigated in this study. Waste generation and bed occupancy represent averaged values at the time the authors received the data from the hospitals. As has been reported by several researchers [4] and results of the present study also showed that waste generation increases with a higher number of beds. As shown in Table 1, the eight hospitals investigated from Group A and 10 from Group B generated 7,920 kg and 1,624 kg of healthcare waste per day, respectively.

3.2 Waste Types Identified

Table 2 shows the result of waste types identified by hospitals. Zero value indicates that there are no particular waste generates due to unavailability of such facility in those hospitals. It was revealed that, two hospitals out of the eight investigated (25%) in Group A separate all healthcare wastes into seven categories called as general, pathogenic, infectious, sharp objects, radioactive, recyclable and other wastes and only these two hospitals (25%) generate radioactive wastes. Another six hospitals out of the eight investigated (75%) in Group A separate their healthcare wastes into five categories.

Table 1. General information regarding the hospitals investigated in this Study

Group	Hospital name	Type of hospital	Waste generation (tons/day)	Number of beds	Bed occupancy (%)
A (Central Government)	Colombo General	National and General	4,444	2,996	84.0
	Angoda Mental	Teaching	329	900	33.3
	Cancer Institute	Teaching	495	879	96.7
	Castle	Teaching	723	485	90.7
	De-Soysa	Teaching	232	227	113
	Eye	Teaching	524	463	64.8
	Kalubowila	Teaching	441	1,094	91.4
	Lady Ridgeway (LR)	Teaching	732	873	26.7
B (Provincial Government)	Angoda Fever	Base	22.2	144	53.3
	Avissawella	Base	654	477	73.8
	Homagama	Base	591	333	78.5
	Moratuwa	District	48.6	64	37.5
	Premadasa Memorial-Maligawatta	District	29.4	53	34.0
	Wetara	District	43.8	107	35.7
	Nawagamuwa	Peripheral Unit	78.5	60	25.0
	Piliyandala	Peripheral Unit	89.6	106	45.5
	Thalangama	Peripheral Unit	48.0	48	54.6
	Athurugiriya	Rural	19.0	53	60.0

Wastes are generated from the various activities carried out in the hospital [10]. Types of wastes and their amount may vary from hospital to hospital and may depend on climatic season, location of the hospital, and many other factors. General wastes produced at hospitals are related to food preparation in the hospital kitchen or canteens, administrative activities and land clearing.

With regard to healthcare wastes in hospitals, different kinds of therapeutic activities such as cobalt therapy, chemotherapy, dialysis, surgery, delivery, resection of gangrenous organs, autopsy, biopsy, paraclinical testing, and injections, among other treatments, are carried out and result in the production of infectious and pathogenic wastes, contaminated sharp objects with patients' blood and secretions, radioactive wastes, and chemical materials, which are considered to be hazardous wastes. Except for Kalubowila (34.0%) in Group A and Angoda Fever (27.0%) and Aturugiriya (52.6%) in Group B, it was found that general waste occupied a large portion of the total waste generated and was more than 60% in both the groups.

3.3 Waste Source Generated

Sources of waste generation may vary from hospital to hospital; the main categories of such sources being patients' services, theaters, laboratories, kitchens, canteens, staff hostels, pharmacies, and gardens. Table 3 shows the presence of different categories of sources of waste generation in the hospitals investigated. Present study revealed that all hospitals investigated in Group A have patients services, laboratories, kitchens, canteens, staff hostels, pharmacies and gardens and only one out of the eight hospitals investigated in Group A did not have theaters as a waste generation source.

All hospitals investigated in Group B have patients' services, pharmacies, and gardens as their sources of waste generation. Meanwhile four out of ten hospitals have theaters, eight out of ten have laboratories, two out of ten have kitchens, four out of ten have canteens, and three out of ten have staff hostels. The number of waste generation sources of the hospitals in Group B as a whole is less than that of Group A.

3.4 Segregation of Healthcare Waste

Identification and segregation of wastes as the main steps in healthcare waste management

[17]. The data collected regarding segregation status by hospitals (Table 4) in this study shows that 100% of the hospitals in Group A separate healthcare by waste category and also adopt a color code system. Meanwhile, three hospitals out of ten in Group B separate their healthcare wastes into four categories: infectious, sharp objects, recyclable, and general wastes. Four hospitals out of ten separated only sharp objects as their healthcare wastes and the remaining healthcare wastes were classified as general wastes. The remaining hospitals investigated in Group B did not practice any segregation of healthcare wastes and collected and disposed of all wastes as garbage. This also demonstrated that none of the hospitals investigated in Group B practice a color code system. Fig. 1 shows segregation of healthcare waste by Castle Hospital as per the color code system.

According to the WHO guidelines, healthcare wastes are categorized as infectious, pathogenic, sharp, chemical, pharmaceutical, radioactive, wastes with high content of heavy metals, and pressurized containers [10]. However, the healthcare waste categorization used by the hospitals investigated in present study is different from that of WHO. For instance, wastes with heavy metals, chemical wastes, and pressurized containers are not categorized or collected as separate wastes and are disposed of with other wastes in those hospitals. Pharmaceutical wastes in those hospitals are not categorized as wastes, but also do not enter the waste stream since outdated pharmaceuticals are returned to the manufacturing companies to be destroyed. The hospitals basically separate medical wastes from the general waste stream at the waste generation points. Thereafter, they are stored and disposed of separately. However, in terms of quantitatively considerations, the segregation of healthcare wastes differed from hospital to hospital or even from ward to ward within a given hospital. Generally, in the wards, doctors and nurses are required to drop the used sharp objects into different containers, but this is not diligently followed. Users of sharp objects sometimes leave them on hospital beds, which could be very dangerous to patients. The mixing of different categories of waste is common in these hospitals. According to recommendations by WHO, hospitals have to provide plastic bags and strong plastic containers, such as empty containers of antiseptics used in the hospital, for infectious waste. Bags and containers for infectious waste should be marked with the biohazard symbol [10]; however, some hospitals

do not label infectious waste in this way. Maintaining a clean environment and disposal of medical waste are social obligations of hospitals [18]. Meanwhile, proper management of medical waste could minimize the risk both within and outside healthcare facilities [19]. The first priority is to segregate wastes, preferably at the point of generation, into reusable and non-reusable, hazardous and non-hazardous components. However, considering these recommendations or WHO guidelines, existing practices followed by the Health-care workers for segregation in most of these hospitals are not satisfactory. The importance of training and education with regards to reduction and proper segregation of healthcare waste has been stated by several researchers [20,21] and might prove as a key factor in bringing a positive change in this direction.



Fig. 1. Segregation as per guidelines of color system at Castle Hospital

3.5 Waste Collection, Storage, Transportation and Disposal

Table 5 shows frequency of waste collection by hospitals investigated in Groups A and B. Six of eight hospitals in Group A transport wastes collected in wards or clinics to waste storage areas daily, and the other two hospitals transport these wastes to storage areas once every three days. In Group B, out of ten hospitals, transport of wastes collected in wards or clinics to storage areas occur daily in three hospitals, once every two days in two hospitals, once every three days in four hospitals, and weekly in one hospital. The place where the hospital waste is kept before it is transported to the final disposal site is termed a "temporary waste storage area." This area must be well sanitized and secured in such a way that it should be accessible only to authorized persons [10]. As per recommendations of WHO

for healthcare waste storage, storage areas are to be free of odor and must discourage the harborage of vermin. Healthcare facilities must provide an enclosed structure such as a shed, garage, cage, fenced area, or separate loading bay to store waste. The holding area should be located away from food and clean storage areas; it must not be accessible to the public, have a lockable door and rigid impervious flooring. Clean-up facilities, spill kits, appropriate drainage, and so on should be provided where wastes are stored in locked bins. A specific area with adequate drainage for washing equipment should be designated. All hospitals investigated in this study have temporary storage areas. The wastes are kept in these temporary storage areas until they are disposed of or transported off-site.

Table 6 shows conditions of temporary wastes storage areas of hospitals investigated in Groups A and B. None of the hospitals investigated in this study carry out compliance checks against the recommendations of WHO for healthcare wastes storage. Only one out of eight hospitals investigated in Group A has a waste storage area with a cemented floor and roof. Meanwhile, five out of eight hospitals have provided open containers for temporary waste storage and two other hospitals in this group store their healthcare wastes on the open ground, at a place designated for the purpose, in the hospital premises. Three out of ten hospitals investigated in Group B store their wastes on the open ground, but these areas have been separated with fixed fences and lockable doors. However, the rest of hospitals in Group B store their healthcare wastes at the designated areas on the open ground. Figs. 2 and 3 show current healthcare waste storage conditions at the hospitals investigated.

Table 7 shows the ways of disposal for each category of wastes by the investigated hospitals in Groups A and B. The upper and lower values in the table (Upper/Lower) represent the values of Groups A and B, respectively. In Group A, all hospitals dispose of their general wastes through municipal councils following WHO recommendations. Six hospitals dispose of their pathogenic wastes through funeral parlors, but the process is not monitored by these hospitals, and is also not recommended as per the WHO guidelines. One out of eight hospitals dispose of pathogenic waste through outsourced incineration. In terms of disposing of their infectious wastes, five hospitals dispose them off

through municipal councils, two hospitals burn them openly on the hospital premises, and others incinerate such waste. As for the disposal of sharp objects, two hospitals incinerate them on the premises, four incinerate them through outsourcing, and the other two burn them openly on the hospital premises. Two hospitals that generate radioactive wastes dispose of their radioactive wastes by outsourcing. Seven hospitals outsource recyclable wastes for recycling and the other one disposes them off openly on the hospital premises. Two hospitals that generate radioactive wastes segregate them from the other types of wastes, and incinerate these wastes on the hospital premises. Fig. 4, Fig. 5 and Fig. 6 show open burning and dumping conditions in some of the hospitals investigated. As is evident, the methods for healthcare waste management followed by these hospitals are quite basic. The Life Cycle Assessment (LCA) and cost analysis for healthcare waste management is vital [22]. These methods should be applied for healthcare waste management in developing countries. As per the Gazette No: 1534/18 dated 02/01/2008, published under National Environmental Act, all healthcare centers including hospitals should obtain Environmental Protection License and a Scheduled Waste Management License from the Central Environmental Authority.

Table 8 shows the status of investigated hospitals in terms of regulation adherence. However, our investigation revealed that eight hospitals from Group A have applied for licenses and have been taking corrective actions to meet the requirements. Meanwhile, in Group B, only one hospital out of ten, i.e., Thalangama hospital, has applied for the license and is working towards fulfilling the conditions. While five hospitals, i.e., Angoda Fever, Avissawella, Homagama, Moratuwa, and Premadasa Memorial Maligawatta hospitals, are planning to apply for these licenses and another four out of ten have taken no action in this regard. Table 9 shows number of hospitals in Groups A and B where workers wear safety equipment. According to the guidelines of WHO, workers who engage in healthcare wastes handling activities should wear safety equipment such as overalls, boots, hand gloves, face masks. But this investigation reveals that in eight hospitals in Group A, healthcare workers wear only hand gloves and in eight hospitals out of ten in Group B wear only hand gloves as safety equipment. However, not only is regulation effective, but

involvement of stakeholders is also vital to the improvement of healthcare management [23].



Fig. 2. Uncovered storage of segregated recyclable healthcare waste for outsource at a hospital investigated in this study



Fig. 3. Temporary storage on open land at the hospital investigated in this study



Fig. 4. Open burning of sharp objects at the hospital investigated

Table 2. Types of healthcare wastes generated from the hospitals

Group	Hospital name	General	Pathogenic	Infectious	Sharp objects	Radioactive	Recyclable	Others	Total
A	Colombo General	3,000	260	1,000	30	3	150	0.5	4,444
	Angoda Mental	300	0	4	5	0	20	0	329
	Cancer Institute	320	70	10	10	25	56	4	495
	Castle	550	20	96	12	0	45	0	723
	De-Soysa	160	23	5	6.5	0	37	0	232
	Eye	450	0.3	66	4	0	4	0	524
	Kalubowila	150	85	50	26	0	130	0	441
	Lady Ridgeway (LR)	600	25	80	7	0	20	0	732
B	Angoda Fever	6	0.5	10	0.7	0	5	0	22.2
	Avissawella	500	45	47	2	0	60	0	654
	Homagama	420	54	60	12	0	45	0	591
	Moratuwa	35	0.25	6	0.3	0	7	0	48.6
	Premadasa Memorial Maligawatta	20	0	7	0.4	0	2	0	29.4
	Wetara	30	0.25	3	2	0	8.5	0	43.8
	Nawagamuwa	67	0.24	7	0.25	0	4	0	78.5
	Piliyandala	75	0.07	8	1	0	5.5	0	89.6
	Thalangama	40	0	2	4	0	2	0	48.0
	Aturugiriya	10	0	5	2	0	2	0	19.0

Table 3. Sources of waste generated

Group	Hospital name	Patients' services	Theaters	Labs	Kitchens	Canteens	Staff Hostels	Pharmacies	Gardens
A	Colombo General	√	√	√	√	√	√	√	√
	Angoda Mental	√	-	√	√	√	√	√	√
	Cancer Institute	√	√	√	√	√	√	√	√
	Castle	√	√	√	√	√	√	√	√
	De-Soysa	√	√	√	√	√	√	√	√
	Eye	√	√	√	√	√	√	√	√
	Kalubowila	√	√	√	√	√	√	√	√
	Lady Ridgeway (LR)	√	√	√	√	√	√	√	√
B	Angoda Fever	√	-	√	-	√	√	√	√
	Avissawella	√	√	√	-	√	√	√	√
	Homagama	√	√	√	√	√	√	√	√
	Moratuwa	√	-	√	-	√	-	√	√

Group	Hospital name	Patients' services	Theaters	Labs	Kitchens	Canteens	Staff Hostels	Pharmacies	Gardens
	Premadasa Memorial-Maligawatta	√	-	-	√	-	-	√	√
	Wetara	√	√	√	-	-	-	√	√
	Nawagamuwa	√	-	√	-	-	-	√	√
	Piliyandala	√	√	√	-	-	-	√	√
	Thalangama	√	-	√	-	-	-	√	√
	Aturugiriya	√	-	-	-	-	-	√	√

Table 4. Segregation at the Various Hospitals Investigated in this Study

Group	Hospital name	Segregation as category wise with color code	Segregation into four category	Segregation only sharp objects	No segregation
A	Colombo General	√			
	Angoda Mental	√			
	Cancer Institute	√			
	Castle	√			
	De-Soysa	√			
	Eye	√			
	Kalubowila	√			
	Lady Ridgeway (LR)	√			
B	Angoda Fever		√		
	Avissawella		√		
	Homagama		√		
	Moratuwa			√	
	Premadasa Memorial-Maligawatta			√	
	Wetara			√	
	Nawagamuwa			√	
	Piliyandala				√
	Thalangama				√
	Aturugiriya				√



Fig. 5. Open burning in metal barrels the hospital investigated



Fig. 6. Dumping in a shallow pit at the hospital investigated

Table 5. Healthcare waste collection patterns

Group	Daily	Once in two days	Once in three days	Weekly
A	6	0	2	0
B	3	2	4	1

Table 6. Healthcare waste Storage conditions

Group	Covered fence and locked area	Cemented floor with roofs	Cemented floor without roofs	Covered container	Open container	Open ground
A	0	1	0	0	5	2
B	3	0	0	0	0	7

Table 7. Ways of disposal for each category of wastes by the hospitals investigated

Disposal method	General	Pathologic	Infectious	Sharp objects	Radioactive	Recyclable	Others
A/B Municipal Council	8/7		5/-				
Disposal by Funeral Parlors		6/1					
Open Dumping	-/2	-/1				1/1	
Incineration in Site			1/-	4/-			2/-
Incineration out site		1/-		2/-			
Bury		-/5					
Outsources					2/-	7/6	
Open Burning	-/1		2/9	2/9		-/3	
Burn and Bury			-/1	-/1			

Table 8. Regulation adherence

Group	Applied and rectifying	Planning to apply	no action
A	8	0	0
B	1	5	4

Table 9. Safety equipment offered by the hospitals

Group	Overalls	Boots	Hand gloves	Face masks
A	0	0	8	0
B	0	0	8	0

4. CONCLUSION

The following are summarized as conclusions of this study.

- Most of the investigated hospitals are aware of the risks or health impacts of healthcare wastes, but are not aware of the environmental damage or pollution that may result from the poor management of healthcare wastes.
- Policies and regulations of healthcare waste management do not address the lack of physical and financial facilities, or the absence of adequate and responsible staff in hospitals.
- In considering sound and environmentally friendly healthcare waste management or the guidelines of WHO in this regard, some healthcare waste practices in the hospitals investigated were satisfactory, but most of them were unsatisfactory.

Using the information obtained through this study, especially observations and literature, the following recommendations are made for healthcare waste management in government hospitals in Sri Lanka.

- I. Formal regulations on healthcare waste segregation, treatment and final disposal must be established.
- II. There should be a healthcare waste management plan, training, and education in each hospital with respect to waste minimization, efficiency from waste segregation up to disposal, and minimization of health risks and environmental pollution.
- III. Adequate and necessary physical or financial facilities, especially waste containers, waste storage, transport, treatment, disinfection, disposal facilities, etc., should be provided for hospitals.
- IV. A separate department with necessary staff including a healthcare waste expert, at least for general hospitals, teaching hospitals, and base hospitals should be employed with respect to healthcare waste management.
- V. It is recommended that the Central Environmental Authority in coordination

with the Ministry of Health formulate a manual of guidelines with respect to healthcare waste management.

- VI. Needle cutters should be provided for hospitals to separate needle sharp objects from the waste stream at their generation points.
- VII. The hospitals should provide necessary training and education for all staff including doctors and other workers with respect to safety, health risks, and environmental issues in healthcare waste handling.
- VIII. Healthcare waste should be transported using dedicated, wheeled, leak-proof containers or vehicles.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Blenkarn JI. Clinical waste management. encyclopedia of environmental health, editor-in-chief Jerome O. Nriagu, Elsevier Science, Philadelphia; 2011.
2. Hossain MS, Santhanam A, Norulaini NAN, Omar AKM. Clinical solid waste management practices and its impact on human health and environment – a review. *Waste Management*. 2011;31:754-766.
3. Silva CE Da, Hoppe AE, Ravello MM, Mello N. Medical waste management in the south of Brazil. *Waste Management*. 2005; 25:600-605.
4. Komilis D, Fouki A, Papadopoulos D. Hazardous medical waste generation rates of different categories of health-care facilities. *Waste Management*. 2012;32: 1434-1441.
5. Blenkarn JI. Standards of clinical waste management in UK hospitals. *Journal of Hospital Infection*. 2006;62:300-303.
6. Coad A. Inter-Regional Consultation on Hospital/Infectious Wastes Management in Developing Countries, World Health Organization, Geneva, Switzerland; 1992. Available:<http://apps.who.int/iris/handle/10665/63022?mode=full>

7. Oweis R, Mohamad AW, Ohood AL. Medical waste management in Jordan: A study at the King Hussien Medical Centre. *Waste Management*. 2005;25:622-625.
8. Patwary MA, O'Hare WT, Sarker. Assessment of occupational and environmental safety associated with medical waste disposal in developing countries: A qualitative approach. *Safety Science*. 2011;49:1200-1207.
9. Patwary MA, O'Hare WT, Sarker. Occupational accidents: an example of fatalistic beliefs among medical waste workers in Bangladesh. *Safety Science*. 2012;50:76-82.
10. Prüss A, Girout E, Rushbrook P. Safe management of wastes from healthcare activities. World Health Organization, Geneva, Switzerland; 1999. Available:<http://whqlibdoc.who.int/publications/9241545259.pdf>
11. Ruoyan G, Lingzhong X, Huijuan L, Chengchao Z., Jiangjiang H., Yoshihisa S., Wei T, Chushi K. Investigation of health care waste management in Binzhou District, China. *Waste Management*. 2010;30(2): 246-250
12. Prem Ananth A, Prashanthini V, Visvanathan C. Healthcare waste management in Asia. *Waste Management*. 2010;30(1):154-161
13. Soliman SM, Ahmed AI. Overview of biomedical management in selected governorates in Egypt: A pilot study. *Waste Management*. 2007;27(12):1920-1923.
14. Mohee R. Medical waste characterization in healthcare institutions in Mauritius. *Waste Management*. 2005;25(6):575-581.
15. Harhay MO, Halpern SD, Harhay JS, Olliaro PL. Health care waste management: a neglected and growing public health problem worldwide. *Tropical Medicine and International Health*. 2009;14(11):1414-1417.
16. Patwary MA, O'Hare WT, Sarker. An illicit economy: scavenging and recycling of medical waste. *Journal of Environmental Management*. 2011;92:2900-2906.
17. Rao SKM, Ranyal RK, Bhatia SS, Sharma VR. Biomedical waste management' an infrastructural survey of hospitals. *Medical Journal Armed Force India*. 2004;60(4):379-382. Available:<http://medind.nic.in/maa/t04/i4/maat04i4p379.pdf>
18. Franka E, Zoka AH EI, Hussein AH, Elbakosh MM, Arafa AK, Ghenghesh KS. Hepatitis B virus and hepatitis C virus in medical waste handlers in Tripoli, Libya. *Journal of Hospital Infection*. 2009;72(3): 258-261.
19. Johannessen JM, Dijkman M, Bartone C, Hanrahan D, Boyer G, Chandra C. Health Nutrition and Population Discussion Paper: Healthcare Waste Management Guidance Note, World Bank, Washington D.C., U.S.A; 2000. Available:<http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/281627-1095698140167/Johannessen-HealthCare-whole.pdf>
20. Mosquera M, André-Prado MJ, Rodríguez-Caravaca G, Latasa P. Evaluation of an education and training intervention to reduce health care waste in a tertiary hospital in Spain. *American Journal of Infection Control*. 2014;42:894-897.
21. Oroei M, Momeni M, Palenik CJ, Danaei M, Askarian M. A qualitative study of the causes of improper segregation of infectious waste at Nemazee Hospital, Shiraz, Iran. *Journal of Infection and Public Health*. 2014;7:192-198.
22. Soares SR, Finotti AR, Silva VPd, Alvarenga RAF. Applications of life cycle assessment and cost analysis in health care waste management. *Waste Management*. 2013;33:175-183.
23. Caniato M, Tudor T, Vaccari M. Understanding the perceptions, roles and interactions of stakeholder networks managing health-care waste: A case study of Gaza Strip. *Waste Management*. 2015; 35:255-264.

© 2015 Athapattu et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history.php?iid=1127&id=22&aid=9218>