

Comparison on Disposal Strategies for Clinical Waste: Hospitals In Sri Lanka

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Abstract: Clinical waste is potentially dangerous because it may contain waste resulting from medical, nursing, dental, pharmaceutical, skin penetration or other related clinical activity. Therefore, it is important to exercise special caution in the management of clinical waste in order to minimize its potential danger to public health and environment. Hence, this research intends to conduct preliminary study on clinical waste management practices with special emphasis to disposal strategies and associated cost. Six case studies, both public and private hospitals were used to collect data covering nineteen semi-structured interviews. Findings revealed that the highest and the least clinical waste generated were infectious and pharmaceutical waste respectively. The cost effective disposal strategies were diesel incinerators (Rs. 28.22 per kg) and dispose in a land (Rs.12.50 per kg). In general, cost for disposal of clinical waste in public sector hospitals were Rs. 84,084.22 per day while private sector hospitals were Rs. 42,101.89 per day. Negligence of the worker's safety and issues from the outsourced companies, were the common and critical challenges for both private and public hospitals

Keywords: Clinical waste, Clinical waste management, Cost, Disposal strategies, Hospitals.

1. Introduction

Clinical waste, one special kind of hazardous wastes, which contains a mass of virus, bacteria and chemical agent, is listed as number one Hazardous Wastes at "National Hazardous Wastes List" in China [1]. The World Health Organization (WHO) recognizes that in many countries improper management and disposal of clinical waste continue a significant threat to the healthy working environment [2]. In general, clinical waste is reflecting high quantity, intensive disposal route and significantly higher costs compared to other waste categories [3]. Thus, many hospitals have faced financial difficulties in managing of clinical waste [4].

Equally in Sri Lanka, although the regulations had been gazetted by Central Environmental Authority (CEA) that improper disposal of clinical waste is an offense, still it remains as a problematic area [5]. Further, there are less special strategies have been established within the local level in order to manage clinical waste in cost effective manner [6]. According to the report identification of cost effective solutions for disposal of clinical waste is one of the main challenge face by hospitals since it require high technological and capital input. Though, few of the major hospitals operate modern treatments or outsource to a private sector, most hospitals are lacking of cost effective options to dispose clinical waste.

Thus, there is a need to develop a proper strategy for clinical waste disposal which is cost effective in long run. Within this context, this research intends to examine the clinical waste management practices in both private and public hospitals in Sri Lanka in order to identify most cost effective disposal strategies to clinical waste. This paper presents disposal strategies, waste composition, cost, challenges and remedies associated with clinical waste management in Sri Lankan hospitals, both public and private located in Colombo district.

2. Literature review

2.1 Clinical waste, Composition and Cost

There are less clear definitions for clinical waste which are generated from hospitals [7]. A study of [8] in the European Union mentioned that the definition of clinical waste can vary significantly among countries. Moreover, there are several terms used to describe clinical waste like medical waste, health care waste, hospital waste, hazardous waste and infectious waste [7]. As per the report of [9] hospital waste can be classified as clinical and nonclinical waste in broader term. Table 1 presents categories of clinical and non-clinical waste with their examples.

Table 1: Categories of clinical waste

Category	Examples				
Pharmaceutical	Expired or unnecessary				
waste	pharmaceuticals and drugs				
Sharps	Needles, syringes, blades,				
	broken glass, scalpels				
Infectious	Lab cultures and stocks of				
waste	infectious agents, wastes from				
	isolation wards, tissues,				
	materials or equipment that				
	have been in contact with				
	infected patients				
Radioactive	Radioactive substances				
waste	including				
	used liquids from radiotherapy				
	or lab work				
Chemical	Solid, liquid and gaseous				
waste	chemicals from diagnostic and				
	experimental work, cleaning				
	materials				
Pathological	Body parts, human fetuses,				
waste	blood, other body fluids				
Non clinical	Packaging materials such				
waste	as cardboard, office paper,				
	leftover food, cans				

Source: ([10]; [11])

In order to develop proper waste management strategies, it is important to characterize the composition of the waste stream with quantities [12].

It varies according to the area, scale of health care facilities, specialty and practice procedure [13].

A research concluded by [14] in UK revealed that the weight of a domestic waste bag varied between 0.6 - 5.6 kg with an average of 2.45 kg, while the range of clinical waste bag weights was 0.5 - 4.0 kg, at an average of 1.45 kg. [15] state that infectious waste is the serious waste category which is accounted for the largest amount with 1241.71 ton/year while pharmaceutical waste is accounted for the least amount with 30.64 ton/year in Croatia. [3] state clinical waste is one waste stream, reflecting high quantity, intensive disposal route and significantly higher costs in UK.

2.2 Clinical Waste Treatments and Disposal Strategies

Safe handling and disposal of clinical waste constitutes as a major challenge of the healthcare sector around the world [16]. [17] mentioned that management of clinical waste are required significant improvements in the current practices in order to ensure public health and environmental protection in Cameroon. In general there is no single disposal practice for the managing of hospital waste. In most cases, various practices including landfills, incineration, autoclaving, and recycling are used in combination [10].

The most common methods utilized in healthcare sector to dispose clinical waste in different countries are shown in Table 2.

Table 2: Disposal methods of clinical w	aste in
different counties	

Country	Disposal Methods			
Algeria	Open Dumping,			
	Incineration			
Mongolia	Open Dumping or			
	Burning, Incineration,			
	Autoclaving			
South Africa	Landfill, Open Dumping,			
	Incineration, Autoclaving			
PalestinianTerrit	y Open Burning, Dumping,			
	Incineration, Thermal			
	Disinfection			
Bangladesh	Dumping			

Dumping, Burning,
Incineration
Incineration, Sanitary
Landfill
Dumping, Incineration
Landfill, Incineration,
Autoclave
Landfill, Incineration,
Autoclave
Dumping
Incineration
Recycling-Reuse,
Pyrolitic Combustion,
Land Fill
Incineration, Autoclave,
Recycling
Landfill, Incineration,
Recycling

Source: [7]

According to the Table 2, incineration is the most common method while landfill and open dumping methods are also visible in many countries. Most of the countries used two or more than two disposal methods. However Bangladesh, ElBeheira Governorate and Egypt used only one disposal method. In South Korea, treatment on-site, such as on-site incineration and microwaving, is the costeffective treatment of clinical waste [9].

2.3 Clinical Waste Management in Sri Lanka

Although Sri Lanka consists of impressive heath care indicators, certain shortcomings of the health care system are visible due to unequal distribution of resources, lack of funds and long term political and bureaucratic commitment towards health issues and poor macro- and micro-health planning [18]. According to the Sri Lankan [12] eight categories of clinical waste were identified, such as infectious waste, pathological waste, sharp waste. pharmaceutical waste, genotoxic waste, chemical waste, radioactive waste, pressurized containers and waste with high content of heavy metals. Table 3 has been extracted from the draft report of Situation Analysis and National Action Plan, 2001 which presented the results of an initial assessment undertaken in various medical institutes by Ministry of Health. It illustrates the production of non-risk and hazardous health care waste per district in Sri Lanka.

Table 3:	Non risk and hazardous health care waste
	per district in Sri Lanka

		Ton/day	Health
District		hazardous	incunti
District	Non	nazaruous	Care
	risk		%
Colombo	11.84	3.28	26.8%
Gampaha	4.15	1.28	10.5%
Kandy	2.98	0.91	7.5%
Kurunegala	2.28	0.76	6.2%
Galle	2.45	0.74	6.0%
Anuradhapura	2.31	0.63	5.2%
Ratnapura	1.73	0.53	4.4%
Badulla	1.89	0.53	4.3%
Kalutara	1.50	0.48	3.9%
Jaffna	1.36	0.41	3.4%
Matara	1.24	0.34	2.8%
Kegalle	0.69	0.29	2.4%
Matale	0.63	0.28	2.3%
Puttalam	0.55	0.24	2.0%
Batticaloa	0.91	0.26	2.1%
Ampara	0.48	0.21	1.7%
Polonnaruwa	0.35	0.16	1.3%
Nuwaraeliya	0.38	0.16	1.3%
Hambanthota	0.34	0.16	1.3%
Monaragala	0.37	0.16	1.3%
Trincomalee	0.34	0.15	1.2%
Vavuniya	0.25	0.11	0.9%
Mullaitivu	0.14	0.07	0.6%
Mannar	0.09	0.04	0.3%
Killinochchi	0.06	0.04	0.3%

Source: [6]

Colombo represents highest percentage of healthcare waste with 26.8% while Mannar and Killinochchi show least percentages with 0.3%.

Table 4 indicates the treatment technologies used for clinical waste management extracted from the same report [6].

Treatment	Description				
Technology					
Burial	 Infectious and general waste 				
	are being buried in some of				
	the health institutions				
	where land space is				
	available				
Open burning	 Mixed waste or infectious 				
	waste separated are being				
	burnt				
Barrel	 Infectious waste are being put 				
incinerators	to a barrel placed on bricks				
	and then burnt				
Sharp pits	• Deposit sharps in a pit layer				
	wise covering with lime				
Needle burners	 Burning of infected part of 				
	the syringes				
Incineration	 Use low temperature 				
	(below 1000'c) single				
	chamber incinerators				
	• Use dual chamber high				
	temperature (above				
	1000'c) incinerators for				
	incinerating infectious				
-	waste and sharps				
Steam	 Autoclaving- laboratory 				
Sterilization	cultures and some				
	autoclayed before disposed				
	 Indirect Steam 				
	- Indirect Steam Sterilizationt				
Chemical	 Some infectious waste are 				
disinfection	chemically disinfected				
	(Sodium Hyper Chloride)				
Placenta nits	 Placenta are put in to a series of 				
i iacenta pits	nits alternatively for natural				
	digestion				
Sri Lanka					
Sii Dunna					

Table 4: Treatment technologies of clinical waste in

Source: [6]

As per the report on Situation Analysis and National Action Plan, 2001 by the Ministry of Health Sri Lanka [6], the most popularly used technologies for the clinical waste management are autoclaving and incineration. Moreover, the choice of treatment technology is depend on the various factors such as, local conditions, impacts to public health and the environment and the overall waste management strategy of the country.

3. Research Methodology

The research was carried out under qualitative research approach. Data were collected from an extensive literature review and nineteen semi structured interviews. The interviewees were qualified professionals in clinical waste management involved in health care sector in Sri Lanka. Literature review was mainly focused to identify clinical waste types, classifications, composition, disposal strategies and cost associated with clinical waste in locally and globally.

Interviews were focused on gathering data from both private and public hospitals in Sri Lanka, mainly to identify the most cost effective disposal strategies to clinical waste. "Hospital" was considered as unit of analysis for this study. Six hospitals located in Colombo were selected from both private and public as illustrate in table 5. Colombo district is selected for data collection since it generates the highest amount of health care waste in Sri Lanka.

Table 5: Interview profile

Case	Sector	Designation of the			
(Hospita	l)	interviewer			
А	Private	Health and safety			
		consultant			
		Senior executive			
		housekeeper			
		Executive housekeeper			
		Pharmacist			
В	Private	Senior manager support			
		service			
		Senior executive facilities			
		Chief pharmacist			
С	Private	Housekeeping executive			
		Pharmacist			
D	Public	Nursing officer			
		Public health inspector			
		Chief pharmacist			
E	Public	Infectious waste control			
		officer			

		Public health inspector Chief pharmacist
F	Public	Nursing officer Public health inspector Chief radiologist Chief pharmacist

Content analysis was used for analysis the qualitative data gathered from the cases.

4. Research Findings

The findings of the study present in four broad headings as following through the cross case analysis of the six cases covering six categories of clinical waste.

- Composition of clinical waste
- Disposal strategies and relevant challenges with prevailing remedies of clinical waste
- Cost of clinical waste disposal
- Cost effective clinical waste disposal strategies

4.1 Composition of Clinical Waste

Composition of each categories of clinical waste generate per day is presents at table 6.

Case/Hospital	Pharmaceutical waste	Sharp waste	Infectious waste	Pathological	waste Radioactive waste	Chemical waste
Private A	3.33	15	86	12	0	0
kg/day B	3	13	245	14	0	0
С	2.8	35	230	15	0	0
Public D	32	25	600	50	0	0
kg/day E	16.62	20	360	31	0	0
F	19	216	183	25	10	0

Table 6: Composition of clinical waste

Accordingly it is clear that infectious waste, sharp waste, pathological waste and pharmaceutical waste are the most common clinical waste types in Sri Lanka. Among them infectious waste is the critical waste category which is generated a massive quantity in almost all the cases excepting the case A. Pharmaceutical waste represents least generating quantities in all the cases excepting the case D. Further, only one hospital generates radioactive waste around 10 kg per day and none of the hospital reported on generating chemical waste. In general, hospitals generate sharp and pathological waste below 25 kg/day and more than 200 kg/day of infectious waste. [21] revealed that sharp, infectious pathological and waste reported generating less than 30 kg/day in Philippines. Accordingly, Sri Lankan hospitals generated more infectious waste than other countries.

However, study of [15] proved that infectious waste is the serious waste category which was accounted for the largest amount with 3401.94 kg/day while pharmaceutical waste was accounted for the least amount with 83.94 kg/day in Croatian counties which is more similar to Sri Lankan findings. Therefore, as mentioned by the [19] clinical waste compositions may differ from country to country.

4.2 Disposal strategies, challenges and remedies

In house Diesel incinerators, gas incinerators and outsourcing (for incineration) are the common strategies identified for the infectious waste management in the current practice of private hospitals and associated challenges as follows.

- Outsourced companies are buying limited categories of infectious waste and only more than 150 kg of clinical waste
- Having fix rate for the outsource companies
- Absence of the outsourced company to collect the clinical waste
- Breakdowns of the hospital incinerator or the outsourced companies' incinerators
- Impossibility of using invertech machine for infectious waste

The empirical findings distinguished the need of regularly conducting awareness programmes, providing Personal Protective Equipment (PPE) and signing an extra agreement with another company to face the emergency situations like machine breakdowns and absence of the outsourced companies as remedies for afore mentioned challenges.

With reference to public hospitals, hydroclavin machine and outsourcing are the common strategies identified and associated challenges as follows.

- Attitudes of the patients and Patients' behaviour
- Unawareness of the staff regarding the clinical waste management and the colour code system
- Lack of space to use incinerators
- Problems from the animal's
- Increasing outsource company charges
- Lack of safety bins to collect infectious waste

Accordingly, public and private sector hospitals are facing different challenges mostly associated with outsourcing companies.

Some clinical waste placed with the domestic waste is the critical challenge in Greece [20]. Equally, this is the common challenge faced by the Sri Lankan public sector hospitals as well. Conducting awareness programmes to each and every employee, taking action to build a closed areas, daily visiting the wards, conducting audits, appointing separate person to handle waste management of each ward are revealed as remedial actions, mostly visible in public sector hospitals in Sri Lanka.

With reference to sharp waste, gas incinerators, invertec machines and the diesel incinerators are the strategies used by the private sector while all the public sector used to outsource their waste to outsourcing companies. Both private and public sector hospitals have common challenges and similar remedies for management of sharp waste which is more similar and common to the infectious waste.

Further, findings revealed that both public and private sector hospitals has outsourced the management of pharmaceutical waste. The outsourced companies dispose these waste in separate lands as disposal strategies and associated challenges as follows.

Table 7: Pharmaceutical waste management
challenges

Public sector	Private sector
 Changing the • 	Negligence of
prescribing pattern	the workers
 Changing the 	Issues from the
 drugs policies 	outsourced
 Threats from the rats 	companies
 Wrong estimations 	Safety issues
•	

Exchanging the pharmaceuticals with the suppliers before expiring and providing special safety equipment for the employees were identified as remedies for the private sector hospitals and sending the pharmaceuticals to the Medical Supply Division (MSD) before expiring and transferring the unnecessary pharmaceuticals to other hospitals are distinguished as remedies for the public sector hospitals.

Referencing to the pathological waste, incinerators and burying in the cemetery are the disposal strategies used in the private hospitals while transferring to florists and outsourcing are the strategies for the public sector. Radioactive waste is identified only in one hospital and none for the chemical waste. All these categories of waste are experiencing fewer manageable challenges. Next section of the paper presents the cost of the each disposal strategies discussed.

4.3 Cost of clinical waste disposal

Table 8 demonstrates the cost in Rupees (Rs) per kg for the each categories of clinical waste.

Table 8: Cost of clinical waste in Rs. per kg

Case/hospital		Pharmaceutical waste	Sharp waste	Infectious waste	Pathological waste	Radioactive waste
	А	58.01	89.64	89.64	89.64	0
Private	В	62.00	66.83	92.50	10.25	0
Rs/kg	С	59.52	28.22	28.22	18.00	0
	D					
Public		12.50	87.00	53.52	16.33	0
	E	20.05	71.75	91.75	16.07	0
Rs/kg		21.66	29.66	29.66	39.02	29.66
	F					

Findings revealed that some private and public hospitals allocated more cost on infectious and sharp waste while some allocated less cost. According to table 8, 89.64 and 92.50 Rs/kg are the highest cost for the sharp and infectious waste respectively while 28.22 Rs/kg is the lowest cost for both sharp and infectious waste. Though, for both highest and lowest cost, disposal strategies for sharp waste are incinerators, the highest is used LP gas where the lowest is used diesel. Thus, diesel incinerator is more cost effective than the gas.

Further, findings revealed that private sector allocates high cost on pharmaceutical waste while public sector allocates less cost. According to table 8, 62.00 Rs/kg is the highest cost for the pharmaceutical waste while 12.50 Rs/kg is the lowest cost.

Most of the hospitals spend less cost on pathological waste. However, cost of case A is excessively high compared to other hospitals, since this uses incinerators. Accordingly 89.64 Rs/kg is the highest cost for the pathological waste while 10.25 Rs/kg is the lowest cost. Here, only one hospital generates radioactive waste and the cost is 29.66 Rs / kg.

In summary, figure 1 illustrates the total clinical waste of public and private hospitals per day in Rupees in Sri Lanka.



Figure 1: Total cost of clinical waste

According to the figure 1 the highest cost for clinical waste are reported Rs. 84,084.22 per day for the public sector and Rs. 42,101.89 per day for private sector. Accordingly public hospitals spend double in cost like private hospitals on clinical waste disposal.

4.4. Cost Effective Clinical Waste Disposal Strategies

According to the findings, highest cost for infectious waste represented the outsourcing strategy would be 92.50 Rs/kg while the lowest cost represented the incinerator would be 28.22 Rs/kg. Generally, the highest cost represented for gas incinerators while the lowest cost represented for diesel incinerators. Therefore cost effective strategy for infectious waste is identified as diesel incinerators.

Sharp waste cost detail both highest and least cost represented the incinerators would be 89.64 Rs/kg and 28.22 Rs/kg. However in here also highest cost represented gas incinerators while least cost represents diesel incinerators.

Pharmaceutical waste represented the outsourcing strategy would be 62.00 Rs/kg while least cost represented the dispose in a land strategy would be 12.50 Rs/kg. The reasons for this deviation is nonincrease of cost per kg align with increasing quantities of pharmaceutical waste and labourer cost. Hence dispose in a land is identified as the cost effective strategy for pharmaceutical waste disposal.

According to the pathological waste disposal cost detail, highest cost represents incinerator would be 89.64 Rs/kg while least cost represents the strategy of burying in the cemetery would be around 10.25

Rs/kg. Thus, cost effective strategy for pathological waste is identified as burying in the cemetery. There is only one strategy for radioactive waste and the cost would be 29.66 Rs/kg. Accordingly Table 9 illustrates the summary of cost effective disposal strategies and associated cost for different categories of clinical waste.

Table 9: Cost effective	disposal strategies for
clinical	waste

	chilical waste	
Type of waste	Strategy	Cost
		Rs/ kg
Infectious and	dDiesel incinerator	28.22
Sharp waste		
Pharmaceutical	Dispose in a land	12.50
waste		
Pathological	Burying in the	10.25
waste	cemetery	
Radioactive	Outsource	29.66
waste		

5. Conclusions

Improper management and disposal of clinical waste continue a significant threat to the healthy working environment. The empirical findings recognized that, public hospital generates more clinical waste than private hospitals mainly due to high number of patients. Infectious waste reported as the serious waste category which is generated in massive quantities in all the cases. Apart from that findings revealed none of the hospitals generate chemical waste and only one hospital reported in generating radioactive waste.

Public hospitals were allocated Rs.84,084.22 per day while private hospitals were allocated Rs.42,101.89 per day for management of clinical waste. Simply public hospital cost was approximately double in amount compare to private hospitals. Gas incinerator, diesel incinerator, hydroclavin machine and outsourcing were distinguished as infectious and sharp waste disposal strategies, outsourcing and dispose in separate lands were identified as pharmaceutical waste disposal strategies, incinerators,

burying in the cemetery, transferring to florists and outsourcing were identified as pathological waste disposal strategies and outsourcing and transferred to the sea through drain line were distinguished as radioactive waste disposal strategies.

Issues from the outsourced companies, negligence of the workers, safety issues were the common and critical challenges for management of clinical waste. Finally the empirical findings recognized the cost effective disposal strategy for infectious waste and sharp waste as diesel incinerators would be 28.22 Rs/kg, dispose in a land as pharmaceutical waste would be 12.50 Rs/kg and outsource strategy for pathological waste would be 10.25 Rs/kg.

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