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Finding an Optimum Technology for Medical Waste Management at Upazila & Rural Level in Bangladesh

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Abstract

In this study, Singra Upazila of Natore district in Rajshahi division has been selected to achieve an effective and sustainable medical waste management system for the rural area of the country. Different types of HCEs such as upazila health complex, union sub centre, union health and family welfare centre, community clinic and Private clinic and diagnostic centre of the upazila were included in this study. To find the present Medical Waste Management (MWM) situation field observations were conducted at HCEs of the upazila. It helped to find the current practice of waste separation, handling, storage, treatment and disposal. A structured questionnaire was designed to collect information regarding public knowledge about MWM. Interviews were conducted with people involved in providing medical services and handling and disposing medical waste. After getting all the data from field observation and questionnaire survey, the results are accumulated by using MS Excel software. After that, results were presented by tables, graphs and charts. A GIS map also prepared to show the positions HCEs in the study area. It helped to show the communication system of the upazila. It also helped to visualize the current status and future system of MWM for the study area. To finding the possible optimum technology MCDA matrix were used. Finally, analysing all data, there were suggested possible solution solutions for different HCEs to improve of current MWM system.

Keywords: Medical Waste, Hazardous, Rural, Health Care, Technology, MCDA Matrix

1 Introduction

Current day's Medical Waste Management (MWM) is thought to be the important issue for both industrialized and developing countries. The unsafe disposal of medical wastes increase the possibility of transmitting hepatitis B and C, HIV and other blood-borne diseases (Akter et. al., 2002). About 5.2 million people including 4 million children die each year from waste-related diseases all over the world (Akter, 2000). Healthcare establishment (HCE) of Bangladesh is rapidly increasing (DGHS, 2014a). Therefore, it is necessary to focus on the medical waste management system throughout the country from urban to rural level.

From previous studies, it was found that the non-government hospitals managed medical wastes better than the government ones (Biswas et. al., 2011). A few NGO's are working on MWM (Hasan et. al., 2008). Although there is a future action plan of Ministry of Health and Family Welfare (MoHFW) of Bangladesh, but the overall present scenario of MWM in rural areas is not satisfactory (MoHFW, 2011).

In this study, Singra Upazila of Natore district has been selected which having an upazila health complex, 12 union health complexes, 42 community clinics and 3 diagnostic centres (DGHS, 2014b). The objectives of the present studies are knowing the current status MWM including waste generation and waste management in different HCEs of Singra upazila. Considering current situation and characteristics of the study area, we would try to find a most possible approach and optimum technology for MWM.

2 Materials and Method

2.1 Background information

In this study, Singra Upazila was selected. Singra upazila is situated at Natore district in Rajshahi division. It approximately lies between 24°24' to 24°42' north latitudes and between 89°02' & 89°21' east longitudes. The upazila is bounded on the north by Bogra district, the east by Sirajganj district, the west by Noagaon district and the south by Gurudaspur upazila of Natore District. The total area of the upazila is 528.46 square kilometer. There are 439 villages, 12 unions and only one pourashava in this upazila. The population of the upazila is 3,56,776 where 1,79,431 are male and 1,77,345 are female. In total 65% of them are educated. There are 250 km of pucca road, 16 km of semi pucca road and 613 km of katcha road in this upazila.

2.2 Selection of the study area

According to DGHS (2014b), the upazila has an upazila health complex (UHC), 4 Union Sub Centres (USC), 8 Union Health and Family Welfare Centres (UHFWC), 42 community clinics (CC) and 3 registered diagnostic centres.

But the number of private clinic and diagnostic centre were increasing. For this study, the upazila health complex, 4 Union Sub Centres, 7 Union Health and Family Welfare Centres, 22 community clinics and 6 private clinics and diagnostic centres were selected.

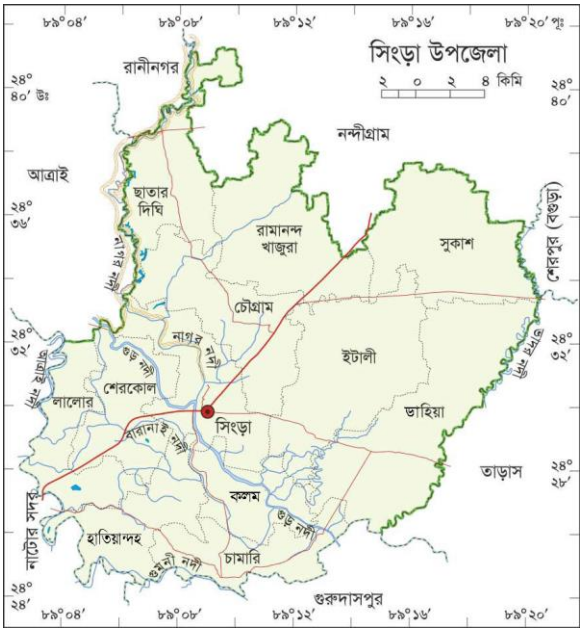

Figure 1: Map of Study Area (Source: www.singra.natore.gov.bd)

2.3 Methods

This study was carried out from February 2015 to December 2016. The methodology of the study includes field observation, questionnaire survey and interviews and Multi Criteria Decision Analysis (MCDA) was used to choose the best available technology for waste treatment. Several factors are considered to design an effective MWM system like human health, economy, environment, society, cultural heritage etc. There were several types of HCEs like UHC, UHFWC, USC, CC and Private Clinic (PC) & Diagnostic Centres (DC). Firstly, it was necessary to find out which would be optimum approach or system. After that appropriate technology would be determined.

2.4 Field observation

Field observations will be conducted at 40 different health care establishments (HCEs) in Singra upazila. We will try to find out the waste generation and its characteristics, current system of waste separation, handling, storage, treatment and disposal.

2.5 Questionnaire survey

A structured questionnaire will be designed to collect information regarding public opinion on current MWM system and which approach and technology they choose. Interviews will be conducted with people involved in providing medical services and handling and disposing medical waste.

2.6 Medical Waste Management Approaches

Two types of approaches were considered. They are Combine Centralized Practice (CCP) and Individual Practice (IP). Combine Centralized Practice is a process where all the HCEs maintain a system together. The main system will run from a centre. Here main waste treatment plant and disposal system will be centralized. All the other HCEs store their MW for a certain period through in-house management system. Then the MW will be collected by a waste collection vehicle. The vehicle will be return to the plant with collected waste. Then all the waste will be treated and disposed together. The system is currently practiced in Dhaka city. In this system extra transport cost is added. All the HCEs have to pay an amount of service fees to get the service. But the most important thing is the approach needs good road communication and transportation facility.

On the other hand, individual Practice (IP) will operate individually among the HCEs. In this system no transport cost is needed. But maintenance cost is needed which will be provided individually. It also needs the skilled person for maintenance in each HCE.

2.7 Selection of Alternative Technologies

For the study, several available technologies and system were selected. Some of them were practiced in Bangladesh, some were practiced in other countries and some were previously suggested. List of alternative technologies is given in below (Wittet, 2004 & WHO, 2014).

1. Modern Incinerator
2. Autoclaving
3. Chemical treatment
4. Micro wave (e.g. STERILWAVE)
5. Low Cost Concrete Incineration
6. Mini Incinerator

2.8 Evaluation Criteria

The criteria of evaluation were selected very carefully. It was assumed that the criteria were independent of each other. The study aimed to find out the optimum technology for the medical waste treatment at Upazila and under Upazila level HCEs. So, the socio-economic criteria were deeply concerned. The criteria are:

i. Cost effectiveness (C1)
ii. Types of waste treated (C2)
iii. Volume and mass reduction of medical waste (C3)
iv. Environmental impacts of the proposed technology (C4)
v. Public acceptance (C5)
vi. Operational requirements (C6)

2.9 Data processing and analysis

After getting all the data, those were analysed statically by using Microsoft Excel.

3. Result and Discussion

3.1 Waste Generation

Waste generation rate was varied between HCE to HCE. Different types of HCEs generated different amount

of MW. The amount of waste generation rate in different HCEs is shown in Table 1.

Table 1: Summary of Generated Medical Wastes in Pourashava level HCEs at Singra Upazila, Natore, Bangladesh

Name of HCE	Total WG (kg /day)	Hazardous WG (kg /day)	Average WG (kg /day)	Average % of Hazardous WG
Singra UHC	96	19	25.29	32.76
Janani Diagnostic Centre	15	7		
Singra Diagnostic Centre	11	5		
Al Hera Clinic and Diagnostic Centre	19	10		
Desh Clinic and Diagnostic Centre	11	6		
Mahanogor Clinic	12	5		
Dip Medical Services	13	6		

From table 1 it was found that, in pourashava level HCEs a total 177 kgs of medical waste generated per day in which 58 kgs are hazardous wastes and 119 kgs are non-hazardous wastes.

Table 2: Summary of Generated Medical Wastes in Union Level USCs at Singra Upazila, Natore, Bangladesh

Name of HCE	Total WG (kg /day)	Hazardous WG (kg /day)	Average WG (kg /day)	Average % of Hazardous WG
Chowgram USC	9	4	8.41	45.43
Lalore USC	7	3		
Hulhulia USC	10	5		
Chhatardighi USC	9	4		
Sherkole UHFWC	6	2		
Sukash UHFWC	7	4		
Dahia UHFWC	8	2.5		
Kalam UHFWC	12	4		
Chamari UHFWC	9	3		
Hatiandaha UHFWC	9.5	4		
Ramananda Khajura UHFWC	6	2		

It also found that, Singra UHC produced highest amount of MW as well as hazardous waste also. But hazardous waste production ratio of Singra UHC was lower than others. Because of having more bed capacity and indoor service facility than others, this UHC produced more non-hazardous waste. For that reason, Singra UHC generated 20% of hazardous wastes every day. On the other hands, other HCEs at pourashava level daily generated 13.50 kgs of MW in an average in which 48% of wastes were hazardous.

It was also found that union level HCEs generated less amounts of MW as well as hazardous waste than pourashava level HCEs. But their production ratio of hazardous waste was greater than the pourashava level HCEs. Because they had only outdoor facility and they used a large number of vaccination and first aid surgery.

Table 3: Summary of Generated Medical Wastes in Rural Level CCs at Singra Upazila, Natore, Bangladesh

Name of HCE	Total WG (kg /day)	Hazardous WG (kg /day)	Average WG (kg /day)	Average % of Hazardous WG
Choto Chowgram CC	4	2	5.14	47.34
Boalia CC	6.5	3.5		
joykury CC	7	3		
Dahia CC	3	1.5		
Baragram CC	5.5	3		
Kheerpota CC	4	2		
Pakuria CC	3	1.5		
Bonkuri CC	7	3		
Satpukuria CC	3.5	1.5		
Mahishmari CC	5	2		
Gunaikhara CC	5.5	2.5		
Baro broihati CC	8	4		
Chakpur CC	6	2.5		
Shedhkhale CC	7	3.5		
Putimari CC	2	1		
Tajpur CC	7	3.5		

In village level HCEs, they had also only outdoor facility. Their average daily production of MW as well as ratio of hazardous waste production was close to the union level HCEs. Because their treatment facility was almost similar.

3.2 Existing MW Management System in Different HCEs

Management practice of different HCEs was not up to the mark. Only the Singra UHC had manual segregation facility out of 40 HCEs. That was also the only HCE had separate covered container or bin for waste storage. There were 37 HCEs who used combined container for storage. Between 37 HCEs, 11 of them used covered container and 26 of were used open container. For collection and transportation of waste, only the Singra UHC had a hand cart. There was no treatment facility of MW in any HCE. There were 23 HCEs who used to burn MW in open air. For the disposal of MW there was no sanitary landfill or RCC pit. About 12 HCEs used to normal land burial for the disposal of MW and rests of 28 HCEs used conventional land disposal.

3.3 Approaches for Different HCE

The approaches for MWM are CCP and IP (previously described in 2.6). It was found that CCP would be the optimum approach for the pourashava level HCEs. For pourashava level HCEs it was possible to maintain a CCP system. For CCP system the road communication is very much important. The road communication facility was found satisfactory level. Distances between the HCEs were also negligible. Employees were also interested for CCP system.

On the other hand, union level as well as village level HCEs were situated far from the pourashava area. The road communication was not up to the mark. As the HCEs were located in a Beel area, during the monsoon season the road communication system became very hard. Those HCEs were produced less amount of medical waste. So, it might be un-economical to transport the wastes to pourashava. The road communication facility between HCEs are given in Figure 2.

After analysing all above discussion it was found that, CCP would be the possible optimum MWM approach for pourashava level HCEs. On the other hand IP would be the possible optimum MWM approach for union and village level HCEs. It was also found that Singra upazila health complex would be the suitable place for central MW treatment plant. It had sufficient place to build a central treatment plant and also for disposal. A three wheeler van might be the suitable vehicle to collect waste from other HCEs. Suggested approaches for the different HCEs are shown in Figure 3.

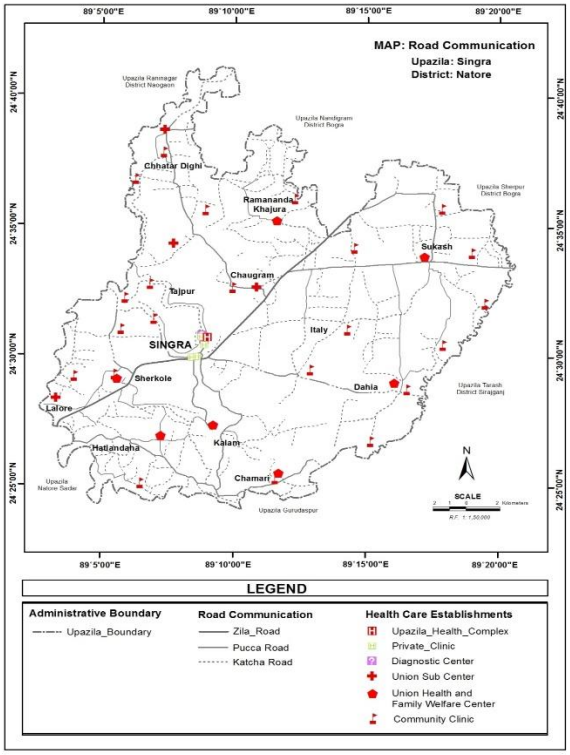

Figure 2: Road communication facility at Singra upazila (Source: www.lged.gov.bd)

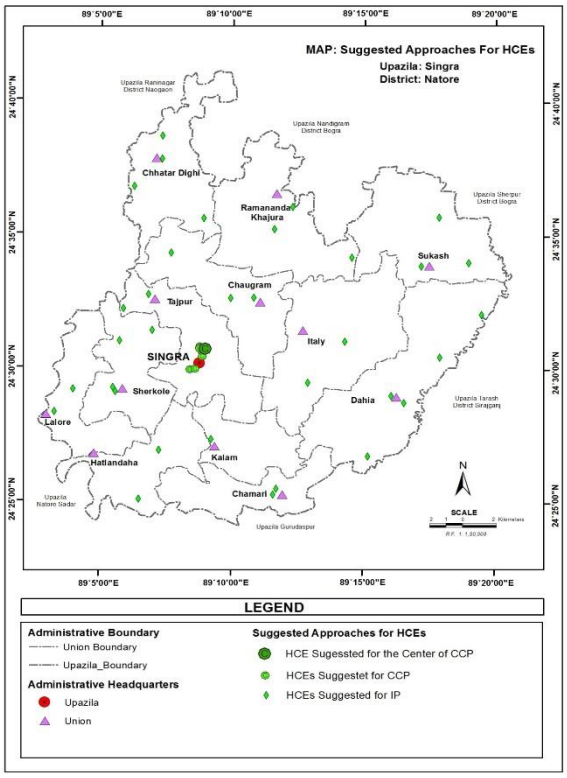

Figure 3: Suggested approaches for different HCEs at Singra Upazila

3.4Ranking the Technology According to Criteria

(A) Cost effectiveness: According to cost effectiveness mini incinerator got the highest rank. Cost effectiveness was focused on both establishment cost and maintenance cost.

(B) Types of waste treated: All the treatment technologies can't treat all the waste. Autoclave, chemical and microwave treatment technologies cannot treat anatomical, cytotoxic and chemical wastes. Incineration is the only option which is suitable to treat all type of MW (WHO, 2014).

(C) Volume and mass reduction of medical waste: Autoclave and microwave can reduce wastes by 80% in volume and by 20–35% in weight. Chemical treatment plus subsequent compacting can reduce the original waste volume by 60-90%. Incineration can reduces waste up to 90 -95% depending on the type of incinerator used (WHO, 2014).

(D) Environmental impacts of the proposed technology: Incineration and chemical treatment have high environmental impact. On the other hands, autoclaving and micro-wave have less impact on environment (WHO, 2014)

(E) Public acceptance: Most of the HCEs employees were preferred common technologies like LCCI and mini incinerator. Low Cost Concrete Incineration (LCCI) got the height preference and chemical treatment got the lowest preference by the employees (Wittet, 2004).

(F) Operational requirements: Autoclaving and micro-wave are the modern technologies. These technologies require

more training and operating skills. On the other hand, incinerators require limited operational skills.

Table 4: Ranking different technologies

Technologies	Rank (A)	Rank (B)	Rank (C)	Rank (D)	Rank (E)	Rank (F)
1. Modern Incinerator	1	2	5	2	4	2
2. Autoclaving	4	1	2	3	3	1
3. Chemical treatment	3	1	1	2	1	1
4. Micro wave	2	1	2	3	2	1
5. Low Cost Concrete Incineration	5	2	4	1	6	3
6. Mini Incinerator	6	2	3	1	5	4

3.5 Weighting the Criteria

For CCP, cost effectiveness and type of waste treated was given more priority in weighting then public acceptance and operational requirements. Because cost effectiveness was a major issue for the pourashava area. With this, different types of waste treatment was also important. Volume and mass reduction was also given importance for CCP because it needed to treat more wastes then IP. The impact on the environment was a significant factor and hence given a higher weighting.

For IP, volume and mass reduction was also given less priority because IP needed very small amount of waste to treat. Operational requirement was given more priority for IP. Because it was very tough to maintain a sophisticated technology in remote area. Cost effectiveness was given more priority in weighting then CCP because in a rural area it needed more economical technology. The impact on the environment was also given more priority.

Table 5: Weighting different technologies

Criteria	Weight (For CCP)	Weight (For IP)
Cost effectiveness	1.5	1.75
Types of Waste treated	1.5	1.5
Volume and Mass reduction of medical waste	1.75	1
Environmental Impacts of the proposed technology	1.75	1.75
Public Acceptance	1.25	1.25
Operational requirements	1.25	1.75

3.6 Optimum Treatment Technology for CCP

After analysing for CCP it was found that LCCI got the highest score. But LCCI and mini incinerator was very close. Whereas CCP needed more waste to burn, so mini incinerator might not be suitable for that. So, LCCI may be the possible optimum technology for CCP.

Table 6: MCDA matrix of different technologies for CCP

Technology / Criteria	Weighting	Modern Incinerator	Autoclaving	Chemical treatment	Micro wave	Low Cost Concrete Incinerator	Mini Incinerator
Cost effectiveness	1.5	1	4	3	2	5	6
Types of Waste treated	1.5	2	1	1	1	2	2
Volume and Mass reduction of medical waste	1.75	5	2	1	2	4	3
Environmental Impacts of the proposed technology	1.75	1	3	2	3	1	1
Public Acceptance	1.25	4	3	1	2	6	5
Operational requirements	1.25	2	1	1	1	3	4
Overall Score		**22.50**	**21.25**	**13.75**	**17.00**	**30.50**	**30.25**

3.7 Optimum Treatment Technology for IP

After analysing for IP it was found that mini incinerator got the highest score. So, mini incinerator may be the possible optimum technology for IP.

Table 7: MCDA matrix of different technologies for IP

Technology / Criteria	Weighting	Modern Incinerator	Autoclaving	Chemical treatment	Micro wave	Low Cost Concrete Incinerator	Mini Incinerator
Cost effectiveness	1.75	1	4	3	2	5	6
Types of Waste treated	1.5	2	1	1	1	2	2
Volume and Mass reduction of medical waste	1	5	2	1	2	4	3
Environmental Impacts of the proposed technology	1.75	1	3	2	3	1	1
Public Acceptance	1.25	4	3	1	2	6	5
Operational requirements	1.75	2	1	1	1	3	4
Overall Score		**20.00**	**21.25**	**14.25**	**16.50**	**30.25**	**31.50**

4 Conclusions and Recommendations

4.1 Conclusions

Health care facility is improving day by day in this country. More HCEs have already been established by the government and private owners. More will be going to establish through the country. The number of HCE is increasing at upazila level to give health care service for the people of remote area. So it is an important period to establish an optimum effective MWM system for upazila level HCEs.

This study showed a scenario of different types HCEs in upazila level. Their waste generation and waste management facilities.

After analysing all the data, geographical situations and suggestions, there concluded a possible optimum solution for the present situation. There were two different approaches for two different levels. In pourashava level, the

CCP approach was suggested. For the waste treatment low cost concrete incinerator was suggested. In union and village level, IP approach was suggested. For the waste treatment mini incinerator was suggested. These MWM systems could be implemented by government as well as non-government or private organizations.

To run these systems the employees will need hand on training on it. Most of the employees both government and private HCEs were interested for training because they were realized the importance of the issue.

4.2 Recommendations

To run these systems the employees will need hand on training on it. Most of the employees both government and private HCEs were interested for training because they were realized the importance of the issue.

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