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Improving the Clinical Waste Management Processes and Practices in Selected Health care institutions, Sri Lanka.

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ABSTRACT: This was an interventional research project carried out to improve clinical waste management (CWM) processes and practices in all the Base Hospitals in the Regional Director of Health Services Gampaha. Interventions were implemented to develop the clinical waste management processes and practices in the health care institutions according to the Health Care Waste Management Guidelines published by WHO, 2014.Both qualitative and quantitative approaches, focus group discussions, checklists and employee's survey was used to assess the processes and practices of CWM. Qualitative techniques were used mainly for gap identification and designing the interventions. Quantitative methods were used to assess the effectiveness of the improvements. Total quality improvement method was designed with extensive literature review, consulting the experts in the field and relevant stakeholders. Qualitative findings confirmed that there were many gaps in the segregation, collection, and storing, external transportation and treatment processes of CWM. Lack of the knowledge among Nursing Officers (NOs) and Junior Health Staff (JHS), poor segregation, inadequate Personal Protective Equipment (PPE) usage, substandard clinical waste (CWs) stores, incineration of general waste and poor supervision by operational managers were identified as the main gaps in the system. Package of interventions designed with the stakeholders helped to increase adherence of CWM practices and processes up to the standard recommended by WHO and enhanced the patient and employee safety. CWM tool made a positive difference in the daily supervision of CWM practices, standard CWs stores and regulated incinerating practices made the treatment process more economical and environmentally friendly. Conducting training programmes on HCWM for NOs and JHSs, availability of continuous logistics like PPEs, waste bins, waste carts and establishing standard CWs stores to prevent possible environmental pollutions through continuous supervision and monitoring was recommended.

KEYWORDS: Clinical Waste Management, Segregation, Transportation, Storing, Treatment

I. INTRODUCTION

Health Care Institutions (HCI) are generating waste in the process of delivering patient care which is called Health Care Waste (HCW). This HCW can be divided as Hazardous and non-Hazardous waste. Non-Hazardous waste is identified as general waste and it is about 75- 90% of total waste produced by health-care providers. The remaining 10–25% of HCW is regarded as "Hazardous" and may lead to a variety of environmental and health risk [1] As far as CWM is concerned, HCI should follow the recommended processes defined as segregation, collection, storage, transportation, treatment, and disposal [1]. Segregation is an important step in a successful waste management program. Segregation and collection of various categories properly are helpful for the successful treatment of HCW. Further Health Care Waste Management (HCWM) to be effective, the waste should be managed at every step, from the origin to disposal [2].

Justification: CWM has become a priority concern not only in Sri Lanka but globally as well. In many countries, awareness about the risk of HCW has increased among medical practitioners and civil society. Increasingly, Medical administrators and staff are expected to take responsibility for the safe disposal of CW generated by their HCIs as a legal requirement in Sri Lanka [3]. Proper disposal of waste within health-care facilities is now widely recognized as a source of avoidable infections, and indirectly it is identified as an indicator of measuring the standards of health care [1].Even though many programs on general waste management have been carried out, it has not been implemented for CWM. It appears that medical administrators are interested in developing and implementing many projects for the quality and patient safety nevertheless HCWM has not been improved through these efforts [4].

Problem statement: Today the health care system is growing rapidly both in government and private health sector of Sri Lanka. In parallel to the transition of epidemiology, demography and technology the demand for

health care also has gone up greatly. As a result of this HCW production also has gone up. In addition to that managing CW efficiently, effectively and in an environmentally friendly manner has become a challenge to the health care managers. Therefore, it is important to assess the problems associated with the CWM processes and practices and bridge the gaps in planning and implementation to achieve the intended standards of CWM.

II. METHODS

This research project focused on improving CWM processes and practices in the RDHS Gampaha area by comparing it with standards of CWM practices published in the WHO Guidelines, 2014.
This was an intervention project conducted in three (3) phases. namely;

Pre-intervention phase: The current process of CWM in all the Base Hospitals (BHs) in the RDHS Gampaha and identification and analysis of gaps in the processes and practices.

Intervention phase: Designing and implementation of interventions to overcome the gaps identified in the processes and practices of CWM in all the BHs in RDHS Gampaha

Evaluation phase: Evaluating the interventions carried out in Phase II

Project setting : CWM processes and practices in all the BHs in the RDHS Gampaha area, BH Kiribathgoda, BH Mirigama and BH Wathupitiwala.

Process Indicators

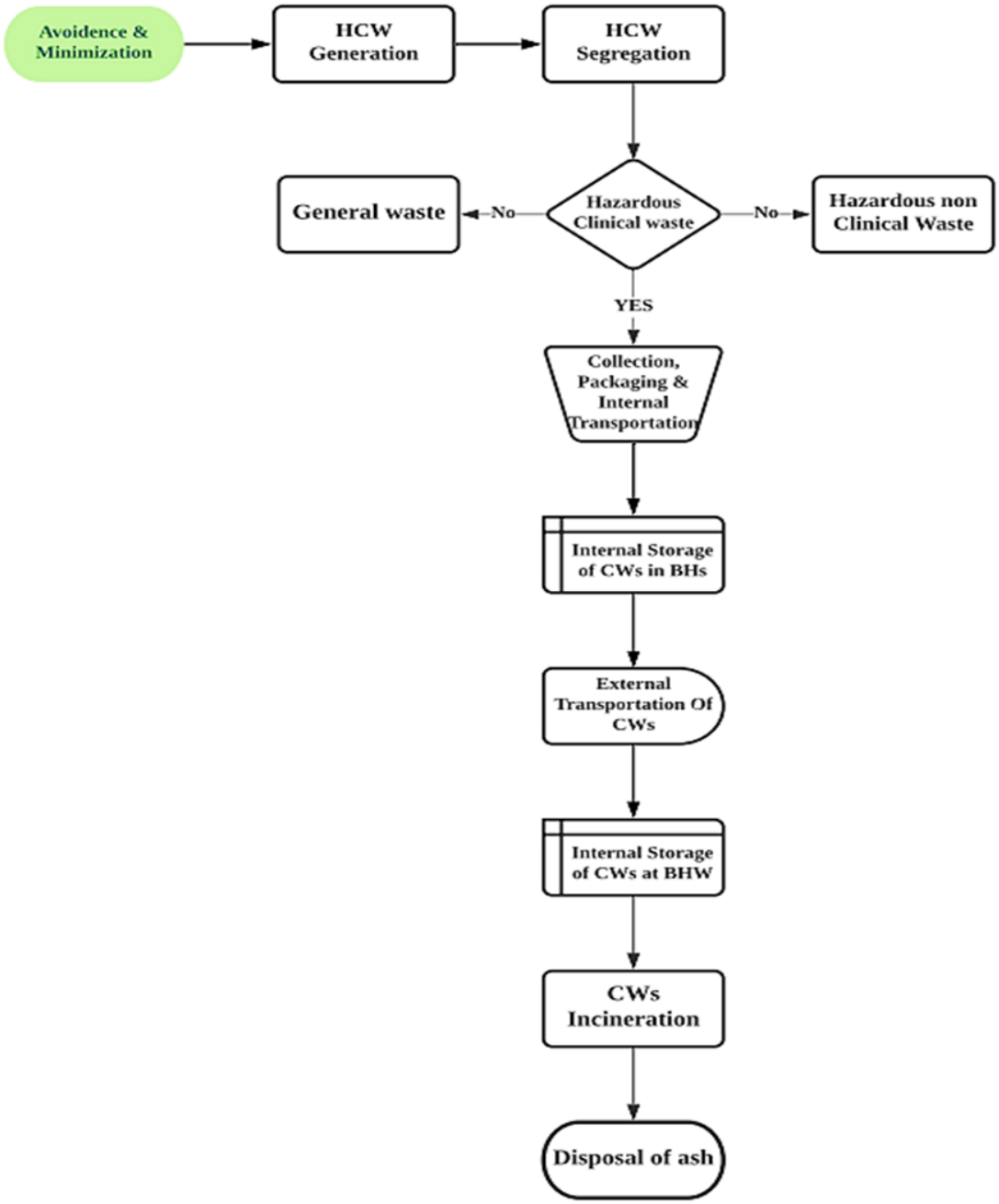
Strategic area	Indicator	Technique
I. Segregation	Availability of Standard sharp bin Knowledge among Nos and JHS Usage of Personal Protective Equipment Timeliness Standard CWs stores Availability of Designated storekeeper Usage of Standard CWs carts Usage of Standard Vehicles Operation of incinerator up to the standards	Checklists/ SAQ
II. Collection		
III. Storing		
IV. Transportation		
Internal External		
V. Treatment		

Outcome indicators

	Strategic area	Indicator	Means of collecting data
I.	Segregation	Level of segregation Knowledge of NO/JHS	Checklist SAQ
II.	Storing	Number of Kg of CWs stored per day Number of Kg of sharp bins stored per day	Desk review
III.	External transportation	Number of turns per week Knowledge among CWs transporters	Checklist SAQ
IV.	Treatment	Number of Kg of CWs treated per litre of Diesel Fuel cost per week Number of kg of CWs treated per day	Checklist

III. RESULTS

The processes and practices of CWM in the RDHS Gampaha were studied extensively, and deficiencies were identified, and interventions to overcome them were made accordingly



3.2 Identification of gaps in the processes and practices of CWM in the BHs of the RDHS Gampaha

Gaps in the CWM process and practices: Data and information gathered through FGDs, checklist and employee's survey were used to identify gaps in current CWM systems in the BHs.

Findings of FGDs: FGD with HOI, Matron, ICN, Nurses and Overseer of the selected BHs revealed that staff were unhappy and experienced several issues in the CWM system. Issues revealed through FGDs were categorized according to the processes of CWM as follows.

Segregation: Shortage of user-friendly waste containers, standard sharps containers and lack of supervision was stressed.

Collection: Delays in the collection of CWs, absence of using PPEs and standard CWs carts were noticed

Storing: Standard CWs stores were not available and a responsible officer was not assigned to operate stores and CWs was wetted due to poor storing conditions.

Transportation: Inadequate number of visits to collect CW and not having a responsible officer had led to poor coordination among HCFs. The CW transporting vehicle was not up to the standards and was not ready for an emergency.

Treatment: Incinerating process was not effective as both general and CWs were treated. PPE usage and supervision of operating the incinerator were inadequate.

III. RESULTS OF CHECKLIST

Based on the findings of the FGDs and WHO recommended guidelines, a checklist was developed to further investigate, the gaps in the CWM processes these findings are summarised below.

Table 1: Gaps in the CWM processes and practices in comparison to standards recommended by WHO, 2014

Process	Gap
Segregation	Sharp containers and CWs containers were not up to the Standards
	Lack of required number of waste containers
	Level of segregation was unsatisfactory
Collection and internal transportation	CWs collection was done at a feasible time for JHS without adhering to a time table
	PPEs usage- only gloves were used (boots, masks, aprons weren't used)
	No separate CWs carts
Storing	Lockable, fully covered, well-built store was not available
	No responsible officer assigned to manage the stores
External transport	Vehicle was not marked with the name and address of the waste carrier.
	PPEs usage- only gloves were used (boots, masks, aprons weren't used)
Treatment	No standard operating procedures to operate the incinerator
	PPEs usage- only gloves were used (Masks, boots and aprons weren't in usage)
	General waste was mixed with the CWs and treated.

Gaps in knowledge and practices of employees involved in CWM : The employee's knowledge and practices of CWM were assessed through an SAQ. The average marks received by NOs and JHS for knowledge was 3.4 out of 15. SAQ measured the self-assessment of staff regarding the best practices and it revealed that staff thought they follow 71% of good practices. Although SAQ revealed staff perceived to have good practices results about their knowledge, FGDs and checklist findings showed that staff knowledge and practices were poor and need further improvement.

Phase Two

Strategies developed and implemented to address identified gaps

Segregation process

- Three Separate capacity building programmes were held for NOs (Participants-BHW-36, BHK-12, BHM-15) and ICNs at their institutions
- Considering the inadequate supervision in the system a supervisory tool was developed and used with the advice of the experts.
- Making available

Standard sharp bins- Mentioned in the CWM guideline
Visibility-Depicting pictograms to increase the adherence to the colour code
Accessibility – Discussed with stakeholders and selected the best place

- Issuing a general circular to guide all the HCFs in the RDHS area to follow good practices in CWM

Collection of CWs at the wards

- Three capacity building programmes were held for JHS (engaged in CWM) of each BHs separately (participants-BHW-12, BHK-6, BHM-3).
- A common timetable was introduced to collect CWs in the hospitals and to be customized according to the needs
- PPEs (caps, masks, apron, boots, and gloves) were made available. Wearing a mask, aprons and boots were made compulsory. The requirement was estimated, and purchasing was done. Sealing of the sharp containers before handing over was made compulsory and materials were supplied

Transportation of CWs in the BHs - Internal transportation

- Capacity building programmes for JHS engaged in CWM of each BHs were held
- A CWs transporting path and a timetable was designed following a discussion with stakeholders.
- CWs carts were modified up to the standards
- usage of PPEs was made compulsory, motivated and made available

Storing of CWs

- CWs store at BHM was repaired up to the standards (Figure-6), in BHK and BHW two alternative places were selected and modified.
- A storekeeper was assigned for each hospital with a duty list.
- Access to CWs stores was restricted for others as kept locked

Transportation of CW in the BHs- external transportation

- A capacity-building programme was conducted for the drivers and assistants engaged in CWs external transportation
- CWs collecting timetable and running route was modified
- Ownership and contacts numbers were mentioned on the CWs transporting vehicle
- PPEs, first aid box, cleaning instrument and materials (mopping, wiper, bucket) were made available

Treatment process

- A capacity-building programme for JHS at BHW was held
- General waste incineration was banned through an internal circular and discussions with Aththanagalla Pradeshiya Sabhawa
- Incinerating operation process was developed up to the standards following the SOPs made by the PI referring to the manufacture's recommendations and literature.

- PPEs usage was made compulsory, available and motivated the usage

IV. RESULTS OF THE POST-INTERVENTIONAL EVALUATION

Improvements in CWM process and practices three months after the interventions

Findings of FGDs: The experiences of health care workers on HCWM process and practices were obtained through FGDs. They agreed that all five processes of HCWM had significant improvement with standard processes and practices in place. Timeliness of CWM, occupational safety of the JHS in the collection of CWs and cleanliness of the wards had improved rapidly after the interventions. The staff mentioned that supervision of the HCWM practices was more methodical and efficient than previous and it has influenced the majority of the staff to adhere to best practices of CWM which were evident from the improvement of the result of CWM index and had reduced conflicts among staff and hospital operations.

V. RESULTS OF CHECKLIST

Segregation: Findings of the checklists revealed that segregation processes and practices had improved significantly reaching the expected standards. Standard sharp containers were not available in the three BHs but after the interventions, they were available in all three BHs. Segregation level of waste was poor in BHK and BHM before the intervention but has improved to average level while segregation level at BHW has improved from average to excellent after the intervention according to checklist results.

Collection: Checklist data revealed CWs collection process has developed 100% achievement in all three BHS where previously PPE usage and adhering to a timetable was not practised.

Table 2: Pre and post evaluation of collection processes and practices at each BH

Indicators for waste collection practices	BH Wathupitiwala		BH Kiribathgoda		BH Mirigama	
	Pre	Post	Pre	Post	Pre	Post
PPE usage during collection	No	Yes	No	Yes	No	Yes
Adherence to a waste collection schedule (Timeliness)	Not adhered	Adhered	Not adhered	Adhered	Not adhered	Adhered
PPE usage during internal transportation	No	Yes	No	Yes	No	Yes
Usage of standard carts during internal transportation	No	Yes	No	Yes	No	Yes
Adherence to an internal transport schedule	Not adhered	Adhered	Not adhered	Adhered	Not adhered	Adhered

Storage: CWs stores were improved to meet the standards and a designated officer was assigned to manage the stores in all three base hospitals which improved the storage management of waste.

Transportation : Visits per each hospital increased from less than one visit to 8 visits per week to an institution increasing the efficiency of external transportation significantly.

Table 3: Pre and post evaluation of the transportation process and practices

External Transportation	RDHS Gampaha		
	Pre Interventional	Post Interventional	Progress
Standard cleaning practice for the Vehicle	No	YES	100%
Usage of Standard vehicle	No	YES	100%
Usage of PPE at least 3 items	No	YES	100%
Knowledge among transporters on CW	Unsatisfactory	Satisfactory	100%
No of visits to BHM and BHK per week	0.833	8	10 times

Treatment: BHW was the sentinel site where final CWs disposal system was located. All the CWs from BHs in the RDHS Gampaha were collected by a dedicated vehicle according to a timetable and brought to the BHW for the incineration. According to the practices before the interventions, both CWs and general waste were treated together as BHW did not have a proper system in place to handle general waste (polythene and paper waste). Interventions of this project introduced standard practices to the treatment process present the changes in practices before and after the interventions. Further, it was observed that CWs brought to treatment were now comparatively dry than before the interventions. Data on waste production and treatment was collected through desk reviews before and after the intervention to evaluate the interventions. Average fuel consumption of the incinerator has decreased to 348L/per week from 560L/per week. Number of CWs treated per day was 581.4Kg but this was dropped to 158.38Kg due to the improvements in segregation, storage and transportation. The efficiency of the incinerator had decreased after the intervention because the burning of general waste was minimized after the intervention.

Overall CWM process and practices: Better segregation and collection practices have reduced the clinical and sharp waste generation per week in all three BHs after the interventions. Reduction in CWs is significant at a 5% significance level in BHW and BHK. In the case of sharp waste, all three hospitals had a significant reduction in the volume of CWs generation at 5% significance level.

Table 4: Pre and post evaluation of average sharp waste collected

Sharp Waste Generation kg/week	Mean value		SD		Mann-Whitney U	P value
	Pre Intervention	Post Intervention	Pre Intervention	Post Intervention		
BH Wathupitiwala	105.56kg	85.5kg	11.78	8.76	82.00	0.01
BH Kiribathgoda	18.91kg	17kg	22.65	4.04	15.50	0.03
BH Mirigama	19.5kg	15kg	8.22	3.13	19.00	0.04

Improvements in eemployee's knowledge of CWM processes and practices: The knowledge among the NOs and JHS on CWM had improved significantly according to the findings where the mean of the scores received for SAQ was 3.4 before the intervention and it has increased to 9.6. According to the Wilcoxon signed ranks test, there is a statistically significant difference between mean scores of the knowledge about waste management practices of this study group (n=49) where Z value was -5.820 ($p<0.001$). As far as practices on CWM are considered, before the intervention they scored 70% for self-assessment of best practices and scored 87% after the intervention. Further knowledge among the CWs transporters had a 43.33% increment.

Table 5: Pre and post evaluation of knowledge among NOs on CWM

Intervention	Mean	Mean rank	SD	Z	Asymp. sig (2 tailed)
Pre	3.45	2.50	3.08		
Post	9.55	23.47	3.40	-5.82	0.000

VI. DISCUSSION

There was a cluster system to collect all the solid CWs from the BHs and transported to the BHW as the sentinel site of treatment. From the generation to storing of CWM steps were handled within the BHs.In this phase where gap analysis was done, it was noted that lack of supervision, infrastructures and knowledge as the main reasons for poor CWM. CWs segregation process was not satisfactory due to lack of knowledge, facilities and supervision. In the collection and internal transportation of CWs, there were delays and it was noticed PPEs usage was absent. Stores were not up to the standard and external transportation process did not cater to the demand of BHs efficiently and effectively. In the apex of the cluster system BHW, they were incinerating both CWs and general waste incurring a big fuel cost. Total Quality Management (TQM) concept was used to develop interventions with the assistance of an expert in the field of CWM. Achieving effective CWM through adopting appropriate standards and training staff, developing infrastructures and making available adequate logistics and enforcing the supervision were techniques used to implement TQM [5]. Giving due consideration to the above findings following features were incorporated to address the main gaps identified in this project.

CWM guideline was made available: Practices of CWM were improved among NOs and JHSs through workshops and supervision

Identified infrastructures were developed: A CWM monitoring tool was introduced to increase the supervision of CWM practices After several rounds of discussions with the stakeholders, few modifications were done to the strategies to make it more user-friendly and convenient. Following the discussion with RDHS Gampaha, a circular including guidance on how to implement CWM practices and processes in a better way was issued to the entire RDHS area. Further planning unit was informed to add HCWM training programs to the annual calendar regularly by RDHS.

Level of segregation: Availability of standard sharp bins, user-friendly labelled waste containers increased the adherence to the colour code and increased level of segregation. Further making available pictograms and directional boards and ensuring close supervision helped to enhance the level of segregation and reduced the volume of CWs and sharp waste generated per week. For example, BHW generated 2940.16 kg CWs and it was reduced to 1181.5 kg following the intervention. According to the knowledge assessment surveys, NOs and JHS had achieved significant improvement in knowledge on CWM which was more helpful to increase the level of segregation and employee safety. The practice of collecting CWs by cleaning service staff was tailed off over a month. After introducing PPEs and recognizing JHS as knowledgeable, they agreed to take over full function of CWs collection and internal transport. Ultimately the system enabled 100% CWs to be collected by JHS only.
Knowledge among CWs transporters also had risen from 25% to 68.33% following the project interventions. The process was now safer and emergency readiness was increased. Also, they were strict to collect only CWs.

Incinerating process had become more efficient, cost-effective and safer as the operators become well informed and trained.

Number of kilograms of CWs and sharps stored per day : Both CWs and sharp waste brought to stores were reduced significantly. For example, in BHW previously-stored 2940.2kg of CWs and it came down rapidly to 1181.5 kg per week. Sharp waste was reduced from 105.6 kg to 85.5 kg per week. This result was due to the rapid development in segregation and stopping the incineration of CWs. Reduction of volume of waste led to curtailing the workload for the JHS and CWs were stored safely.

Frequency of external transporter's visits to each BH, : Enhancement of the number of visits to collect CWs from BHM and BHK gave a solution to lack of freezers in CWs stores and inadequate store spaces. The external transporting process had developed rapidly and the timetable to visit HCFs was redesigned which resulted in a 10-fold increase in visits per month to each HCF.

Number of CWs kilograms treated per day in the incinerator and fuel cost per week : Incinerating process practised earlier did not follow the manufacturer's instruction or standard practices recommended by WHO, 2014. Therefore, the process was not economical, occupationally safe or environmentally friendly. Improved knowledge among the incinerator operators after the interventions optimized the incineration. General waste incineration became zero. It was found that previously BHW incurred Rs: 8618.15 /day to treat HCWs which came down to Rs 4514.70/per day (47.61% cost reduction). Before the intervention, 581.41kg/day of HCW was treated, but, after the intervention, it was reduced to 158.38kg/day As a result of improving the process of segregation and issuing an internal circular to BHW, to stop incineration of general waste, the number of kg of waste treated per day in the incinerator was drastically reduced. Previously 581.41kg were treated per day while it came down to 158.38 kg per day with the intervention. Reduction of daily treating volume of CWs reduced the workload of operators and daily fuel cost was reduced from Rs: 8618.15 to Rs: 4514.70 reducing fuel cost significantly.

Number of kgs of CW treated per one liter of diesel : Before the implementation of this project, BHW did not have a method to dispose of, general waste like polythene and paper waste, both CWs and general waste was incinerated. This practice increased environmental pollution, fuel cost and challenged the use of segregation. As the treatment process was not supervised adequately, the running cost was high.It was observed that the number of treated CWs kg per one litre was reduced to 348 Kg from 559 Kg after the intervention, explained by the wet nature of the CWs that incurred more fuel consumption before improving the storage of CW. Furthermore, it was observed that incinerating of general waste mixed with clinical waste led to minimizing fuel consumption, though the practice was not acceptable as the negative impact on the environment.

Limitations: For this project, liquid, gaseous, radiation like CW was not considered due to the practicability of implementing interventions. Moreover, some interventions such as construction like septic tanks and drainage system at hospitals were not implemented due to the high cost and planning issues.

VII. CONCLUSIONS

This project aimed to improve the CWM current processes and practices in BHs of the RDHS Gampaha by identifying the gaps and implementing appropriate interventions to overcome those gaps. Many gaps were observed in the system of CWM in RDHS Gampaha. They have deviated from the recommendations given by WHO, 2014. Previous processes and practices were not safe for the patient, health workers and the environment. In addition to this, it was not economical. Main gaps were identified in segregation, collection, storing, transportation and treatment. These gaps were overcome by improving the process and practices up to WHO recommended standards. Furthermore, the knowledge gap was identified and strategically the gap was bridged. Provisions of continuous logistic were a huge barrier for the standard CWM. Issuing of the circular on CWM by RDHS influenced all the HOIs and health staff to follow good practices in CWM.

Ultimate treatment of CWs took place at BHW, which was not efficient and cost-effective. Nevertheless, with the introduction of checklists, CWM guidelines, stopping the treatment of general waste and increased supervision had improved the overall efficiency and effectiveness of the system.

Project evaluation showed that there was a significant improvement in both processes and practices following the interventional project of CWM in the RDHS Gampaha.

VIII. RECOMMENDATIONS

To sustain this project, it is recommended to

- Conduct training programmes on HCWM according to a training calendar focusing on essential elements and novel information for relevant staff to improve the processes and practices.
- To make available continuously the required trained Human Resources and logistics like PPEs, Dust bins and waste carts.
- To ensure continuous supervision and monitoring, to reinforce CWM processes and practices.
- To establish Standard CWs Stores (with refrigerator facilities) to prevent possible environmental pollutions.

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