Impact evaluation study
of a pictorial guide for

BIOMEDICAL WASTE MANAGEMENT IN INDIA

Acknowledgements

The Impact Evaluation Study for a Pictorial Guide on Biomedical Waste Management in India is a product of joint research by the Centre for Chronic Disease Control (CCDC), Centre for Environmental Health (CEH) –Public Health Foundation of India (PHFI) and Health Care Without Harm (HCWH).

The Pictorial Guide on Biomedical Waste Management (BMWM) Rules, 2016 (amended in 2018 & 2019), was released in 2020 to provide a quick, user-friendly view of the important elements of biomedical waste handling, treatment, and disposal. This report provides the findings of a study to evaluate the impacts that the pictorial guide has had on the knowledge, attitude, and practices of the study groups regarding biomedical waste management. It also highlights the key challenges faced by the healthcare workers while handling the COVID-19 associated biomedical waste.

We thank our fellow colleagues at the CCDC, CEH– PHFI and HCWH for their valuable support and contributions in development of this report. Last but not the least, we would like to thank all the members of the Health and Environment Leadership Platform (HELP) who had provided their continued support during the study surveys that helped us understand and capture the key issues of concern around biomedical waste management across Indian Healthcare Sector.

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Introduction

Medical care is vital for our life, however the waste generated from medical activities poses a real problem in today's world. Of the total waste produced during healthcare activities, about 75% to 90% is non- risk or 'general' healthcare waste that is similar to the domestic waste which mostly comes from administrative and housekeeping departments of healthcare facilities (HCFs) says WHO. The remaining 10-25% of healthcare waste is hazardous that may create potential environmental and health risks.

Developing countries are resource-constrained when it comes to safe management of hospital wastes (Ali, Wang, Chaudhry and Geng, 2017). Improper management and indiscriminate disposal of biomedical waste causes a direct and serious health impact on the community, healthcare workers and the environment. Individuals exposed to the hazardous healthcare waste (HCW), can be potentially at risk of being injured or infected (World Health Organization, 2015). Therefore, the management of this waste requires increased attention and diligence to avoid adverse health outcomes associated with poor waste management practices such as those leading to exposure to infectious agents and toxic substances.

Safe treatment and disposal of biomedical waste is a prerequisite to ensure environmental, occupational as well as public health. It is of utmost importance that employees should be aware about the hazards of biomedical waste in work environment and about its disposal in the most effective and scientific manner (Rao, Dhakshaini, Kurthukoti and Doddawad, 2018). The management of biomedical waste follows the cradle to grave approach which includes characterization, quantification, segregation, storage, transport and treatment of biomedical waste (Datta, Mohi and Chander, 2018).

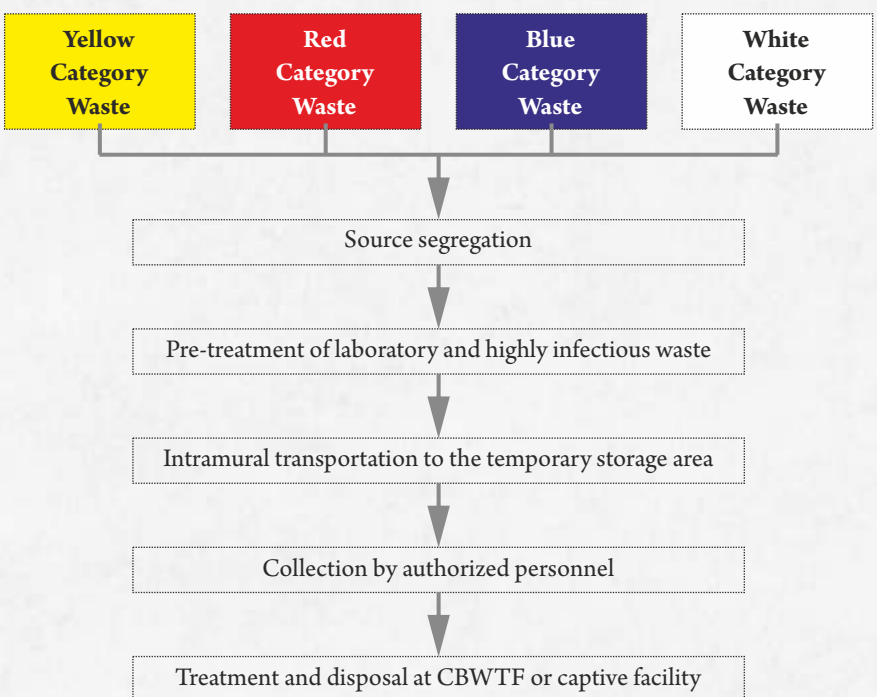


Figure 1: The process flow of biomedical waste management. Source: Created by Ananya Tewari, CCDC- CEH.

Safe handling and disposal of biomedical waste in India: key challenges and evolution of policy framework

In order to ensure safe treatment and disposal of biomedical waste, countries have regulations in place. India has also had the BMWM regulations in place since 1998. Even though India has been among the first countries to initiate measures for safe disposal of BMW, several studies have reported inadequacies in waste management practices across the country. Despite the enforcement of new rules, 'manual sorting of healthcare waste' without any personal protective equipment have been reported to have taken place for waste sorting and opening of the bags of biomedical waste, which is prohibited under the Rules (Datta, Mohi and Chander, 2018). Several institutions in the State of West Bengal considered returning to reusable glass syringes rather than using single-use plastic syringes because of the poor management of the health-care waste (WHO, 2014).

Keeping in view of these challenges, BMWM Rules were amended in 2000 and 2003. During 2002-2004, International Clinical Epidemiology Network evaluated the BMWM practices across primary, secondary, and tertiary health care facilities of 20 Indian States and found that around 82% of primary, 60% of secondary, and 54% of tertiary HCFs in India had no credible BMWM system. In 2008, another study revealed malpractice of collecting sharps waste in plastic bags instead of puncture proof containers, lack of dedicated space for waste storage and the practice of handing over laboratory waste to the external service provider without disinfecting the waste, across nursing homes and smaller hospital establishments in Delhi (Verma, Mani, Sinha and Rana, 2008). Later, in 2009, the State of Gujarat reported 240 people having contracted hepatitis B following reuse of unsterilized syringes (Seetharam, 2009).

To address these challenges, it became pertinent to improvise and enhance the capacity for the enforcement of policy framework. In 2016, new BMWM Rules, 2016 were introduced that replaced the previous regulations. The BMWM Rules, 2016 had wider coverage, simplified colour coded waste categorization, improved transportation and waste disposal methods. The new rules were also subsequently amended in 2018 and 2019, emphasizing on phasing out the use of chlorinated plastic bags excluding blood bags, gloves, urine bags, effluent bags, abdominal bags and chest drainage bags.

Even after the amendments and modifications made to the policy framework governing biomedical waste management in India, safe handling, treatment and disposal of waste generated from healthcare activities still remained a looming concern. In 2016, a report by the Comptroller and Auditor General (CAG) of India highlighted the use of plastic bags instead of puncture proof containers for glass and metal sharps waste across different facilities in Mumbai and Nashik (Kakodkar, 2017). Two of the facilities in Mumbai were also found to have mixed the sharp wastes with the incinerable waste category, stated the CAG report. Another CAG report of 2018 stated that healthcare institutions were functioning without authorisation and the facilities had resorted to unauthorised disposal of biomedical waste in Karnataka (CAG, 2018).

A study conducted by Toxics Link in 2019 across healthcare facilities of Delhi showed that practices in larger establishments were more or less compliant with the new rules, however

smaller establishments were found to be lacking in several aspects such as lack of personal protective equipment (PPE), open waste storage area, manual waste transportation within the facilities, improper waste quantum records and lack of accident reporting (Mahesh and Syed, 2019).

Many of such reported discrepancies are known to have taken place either due to lack of training among healthcare staff or due to the difficulty faced by them while interpreting the rules appropriately. A study conducted in 25 districts spread across 20 Indian States revealed the urgent need to strengthen capacity building and resource investments in BMWM (IPEN study group, 2014).

Improving awareness and building capacity – a potential solution

Raising awareness among healthcare staff about the risks associated with improper handling of biomedical waste is an important aspect in improving the waste management practices. An evaluation of biomedical waste management practice across a tertiary health care centre showed that training and motivation needs to be given paramount importance in order to meet the requirements and specifications of BMWM Rules the management of healthcare waste (Srivastav and Mahajan, 2011). Another study highlighted that Communication; Influence of the environment on employee; How employees think about waste management, are the three primary themes that can impact the overall waste management (Manzi, Nichols and Richardson, 2016).

Another study conducted across 337 healthcare personnel reported that it is important to train the laboratory technicians and multipurpose workers about biomedical waste management and that there is a need to provide PPE and other resources to the staff for improving their compliance with BMWM rules in India (Malini & Eshwar, 2015).

A study suggests that providing training on health care waste management can bring positive changes in attitudes and increase knowledge about healthcare waste management standards among hospital staff (Kumar, Somrongthong and Ahmed, 2016). Similarly another study conducted amongst 210 healthcare workers showed that trained participants had better attitude and practice scores than the untrained ones towards biomedical waste management (Mehta, Shah and Tiwari, 2018). A clinical audit conducted across eight bed intensive care unit in Melbourne concluded that more than one in-service and increased signage is important to bring behavioural change (Hames, 2013). A study of 2016 suggests that healthcare waste management should include a clear description of work responsibilities, occupational health and safety programs, waste minimization and segregation, adoption of safe and environmentally sound technologies, and capacity building to have a holistic approach (Awodele, Adewoye and Oparah, 2016).

In order to ensure increased awareness and improved training among healthcare staff several guidelines, training modules and resource materials are made available to them either by the government or private partners. Such guidelines primarily focus on promoting different ways for adopting safe practices within healthcare facilities towards achieving improved waste management. Some healthcare facilities also develop their own instruction manuals and guidelines that are used for in house training purposes. Most of the guidelines in India are a simplified version of the BMWM rules, that can be easily interpreted and implemented at the ground level.

In September 2009 Centre for Environment Education in collaboration with Environment Science Analysts conducted training intervention programme, Healthcare Establishments Wastes Management and Education Program (HEWMEP) Rajasthan Package II, across 759 primary health centres (PHCs) of Rajasthan. The main objective of the program was to improve the quality of health services across PHCs by developing skills through training among healthcare staff on infection control and healthcare waste management practices. Later a similar training intervention was conducted across remaining 770 PHCs in Rajasthan in order to improve their waste management practices (Mani, 2011).

Challenges of COVID-19

The challenges of managing biomedical waste worsened when the pandemic of COVID-19 hit India in early 2020. India's utmost effort in combating the pandemic of COVID-19 significantly increased the quantity of waste generated from healthcare and quarantine facilities and laboratories, etc., although total biomedical waste from healthcare establishments decreased due to reduced patient load (Goswami et al, 2021). This surge in hospital waste is likely to exert pressure on country's waste management system and jeopardize the environment as well as the community health (Goswami, Goswami, Nautiyal and Prakash, 2021).

To ensure the effective management of COVID-19 biomedical waste, Central Pollution Control Board (CPCB), the apex body constituted under the Ministry of Environment, Forests, and Climate Change to advise the government about the matters of environmental pollution and ways to prevent it, issued Guidelines for Handling, Treatment and Disposal of Waste Generated during Treatment/ Diagnosis/ Quarantine of COVID-19 patients during 2020. The guidelines evolved significantly during March through July, 2020.

The first guidelines issued on March 19th 2020, focused primarily on managing waste generated from isolation wards. During the later amendments it included specifications for quarantine centres, the management of wastewater from treatment facilities, the growing problem of waste handlers and the need for protective gear for sanitary workers along with others involved in the waste management chain. In view of the cases reported about mixing of biomedical waste with general waste at household level across select cities in India, the guidelines were further revised in July 2020. The final review of July 17, 2020 stressed on the segregation of biomedical waste from general waste at homes, with COVID-19 patients to prevent over-loading of the common waste treatment facilities (EPCA, 2020).

Pictorial guide by CCDC and PHFI to aid biomedical waste management in India during COVID-19

In order to strengthen the compliance and implementation of recent modifications made to the biomedical waste management rules and the COVID-19 waste management guidelines, Centre for Chronic Disease Control (CCDC) along with Health Care Without Harm and Centre for Environmental Health (CEH), Public Health Foundation of India (PHFI) developed a pictorial guide. The guide had significant pictorial component reflecting the recent technical changes in the policy guidelines. It had dedicated sections on key aspects of waste management that include segregation at source, waste transportation, storage, pre-treatment, importance of personal protective gear, road to ultimate treatment and disposal of waste, and safe handling of COVID-19 waste within HCFs and quarantine centres.

The pictorial guide was developed keeping in view the requirements of sanitary workers and their supervisors who are at the forefront while handling the hazardous biomedical waste. It was aimed to get utilized in the capacity building exercises conducted across healthcare facilities to help improve knowledge, attitude and practices among health workers including those involved in biomedical waste management chain. Given the pictorial component of the guide, it was also aimed to go beyond the barrier of illiteracy and regional languages in India. The idea was to also get the pictorial used as recall posters that could be put up in different areas of the HCFs. A baseline scoping exercise was conducted before the development of pictorial which included consultations with representatives of public and private healthcare institutes. The consultations highlighted waste segregation, lack of refresher training and the need for additional resource material to aid the overall waste management practices across the HCFs.

The pictorial was disseminated across the member hospitals of Health and Environment Leadership Platform (HELP) and beyond. HELP is a network of 70 members representing about 7700 healthcare institutions, spanning across different states of India. HELP network comprises of a mix of public and private healthcare institutions. The platform is aimed to sensitize Indian healthcare sector about the health impacts of environmental pollution and climate change. It brings together the healthcare sector players under the common goal of adopting environmentally sustainable practices and reducing their ecological footprint.

Rationale for the study

Training is considered as an important phase in the process of acquiring required capacity because it identifies the existing gaps in knowledge, attitudes and skills that affect the individual performance (Manikandan and Anwar, 2008). However, it is equally crucial to understand and estimate the impact of such trainings and awareness interventions. In order to understand and document the impact of BMWM pictorial guide developed by CCDC, it was found to be pertinent to conduct an impact evaluation study capturing the knowledge status of the healthcare facility staff both before and after the dissemination of pictorial guide.

Such analyses help understand the effectiveness of training interventions such as that of pictorial guide and also provide robust database for future studies. The idea was to develop suitable recommendations for improving the efficiency of training and capacity building exercises. A questionnaire based study statistically assessed the scores for knowledge, attitude and practice both pre and post training that was provided on biomedical waste management, to evaluate the impact of training session provided to the healthcare facility staff (Kulkarni et al, 2016).

The study also concluded that the assessment showed positive impact of training among the participants and the fact that such studies are important to be conducted at regular intervals. Similar results were reported in another questionnaire based evaluation that was conducted across a 1000 bedded tertiary care hospital that revealed significant improvements in the skill level of healthcare facility staff after undergoing training on biomedical waste management (Mohan, Prasad and Kumar, 2012). Another cross sectional study was conducted across healthcare facilities of Karnataka that had participated in district level training program, to evaluate the processes of biomedical waste management (Gadicherla, Thapsey, Krishnappa and Somanna, 2016).

Sanitary workers and their supervisors as the study group

For the purposes of capturing the impact of the pictorial on knowledge, attitudes and practices across the HCFs, sanitary workers and their supervisors were selected to form the core of study group. The primary reason for selecting them was that being the first responders to healthcare activities their exposure to the potential risks of biomedical waste, is considered to be the maximum while handling the hazardous biomedical waste. Several studies also suggest that the knowledge gaps mostly exist at the ground level i.e., among the sanitary workers whereas the doctors and nurses are usually found to have a better idea of waste management practices within their healthcare facilities. Knowledge about different aspects of BMWM was found to be high among doctors and nurses across studied sites as compared to paramedical staff (Swathi et al, 2018). A cross sectional study conducted across 253 respondents from a tertiary healthcare facility in Andhra Pradesh reported lowest knowledge mean among housekeeping staff (Aanandaswamy, Rajappa, Narendranath and Ramachandra, 2019).

A similar finding was reported by Anand et al stating that studied group of doctors, nurses and lab technicians were found to have good knowledge, attitude and practice regarding biomedical waste management whereas the same was found to be low across sanitary workers.

It is also reported that bringing change in the attitudes and practices of sanitary staff and their supervisors can significantly improve the management of biomedical waste and reduce their exposure risks. A study conducted across 305 respondents in Haryana, concluded that it is important to conduct continuous training for health personnel with special focus on sanitary staff (Anand, Jain and Dhyani, 2016). Malini & Eshwar conducted a study in 2015 across 337 healthcare personnel in Puducherry, revealing that laboratory technicians and multipurpose workers had poor knowledge about disposal of sharps and that none of the multipurpose workers had received training on biomedical waste management.

A study by Singh & Srivastava in 2013 suggested that the sanitary staff had poor knowledge about the management of biomedical waste although a large percentage of this group showed positive attitude and practice about the same. The study also reported that sanitary staff at the facility were contractual leading to higher turnover of these workers. Therefore, it concluded that there is a need to conduct intensive training programs at regular intervals for all the staff with special focus on the new comers.

Study Objectives

- To capture the change in behaviour, knowledge, attitude and practice (KAP) of hospital staff towards biomedical waste management (BMWM) across Indian healthcare facilities
- To understand and measure the impact of awareness generated through dissemination of Biomedical Waste Management Pictorial Guide
- To understand and document the bottlenecks in practicing BMWM across Indian healthcare facilities

The impact evaluation study aimed at analysing and documenting the change in knowledge, attitudes and practices (KAP) of healthcare facility staff regarding BMWM both before and after the dissemination of pictorial guide.

The study was also aimed at documenting and evaluating the most prevalent waste management practices that exist across healthcare facilities. It was also to highlight practical constraints with respect to the implementation of BMWM regulations at the ground level. Study results have been aimed to provide appropriate recommendations to improve the enforcement of new policies and overall waste management across HCFs.

Sample Size

To arrive at a feasible sample size, calculations were conducted based on the percentage change that we aimed to capture in KAP among the study group. An online sample size calculator (ClinCalc.com) was used to calculate the value of n which came out to be 26. Therefore, a total of 26 participants were interviewed across 13 HCFs. The interviewed staff consisted of 1 sanitary staff and 1 supervisor, forming 2 respondents from each of the 13 HCFs.

Following values were considered during the calculation of n through ClinCalc.com:

Anticipated incidence for Group 1= 87.4%

Anticipated incidence for Group 2= 25.3%

α= 0.05 and Power (1-ß)= 0.95

Change we wish to see= 62.1 % (based on the values as reported in one of the intervention studies from the literature review).

The value for percentage change was considered as 62.1% from a previous intervention study that evaluated the KAP with respect to biomedical waste management in The Oxford Medical College, Hospital and Research Centre, Bengaluru (Sharma, Hiremath, Sudeepa and H. V., 2017). This number is essentially the difference in percentage values depicting knowledge during pre and post intervention i.e., 25.3% and 87.4% respectively. The aforementioned study had reported significant positive changes in KAP post training intervention that was provided to improve the biomedical waste management in the hospital.

One of the parameters was 'segregation of waste at source' for which percentage of correct responses were reported as 25.3 before the training intervention. After providing them training on BMWM this value rose to 87.4%. The reason behind choosing this value to calculate the sample size was the fact that segregation at source is considered as the most crucial step in BMWM. Segregation at source is the basic principle of BMWM along with waste reduction (Dutta et al, 2018). It is the first and most essential step in biomedical waste management (Sengodan, 2014). If an intervention is able to bring change in KAP with respect to this parameter, several bottlenecks can be addressed. Also choosing this value was aimed at achieving higher impact by selecting a smaller study group.

Changes in study design and sample size due to the pandemic

Initially in-person site visits were planned to interview the participants but due to the COVID-19 associated travel restrictions and potential risks, the study design was changed to conduct the interviews telephonically. It is important to note that the study was conducted during the peak of COVID-19 spread across India which had impacted the study course in several ways. There were significant delays in data collection across the study group. Two of the HCFs and their staff dropped out of the study during post-test interviews. This was the time when second wave had hit the country and healthcare workers being in the frontline had faced the maximum challenges. Two of the HCFs across the study group reported that several of their sanitary staff and supervisors left the job due to the fear of getting infected or had actually gotten positive with the virus. Out of 13, 2 HCFs had to be eliminated from the study group as the team was unable to collect post-test data for the staff that had left the job at HCF. This reduced the final sample size from 13 to 11.

Materials and Methods

The study focused on evaluating the impact of BMWM pictorial guide, an educational intervention, among sanitary workers and their supervisors within the HELP member healthcare facilities. It is a quasi-experimental study with pre-test and post-test design for evaluating the impact of educational intervention on KAP regarding biomedical waste management among study group. The study used questionnaire-based assessment both before and after the dissemination of the BMWM pictorial guide.

The questionnaires were developed by the team at Centre for Chronic Disease Control (CCDC) and Centre for Environmental Health (CEH) on the basis of various training-associated factors. The pre-test and post questionnaires consisted of a total 35 and 31 questions respectively, with most questions having multiple choices. As the first step, HELP members were contacted by CCDC-CEH team to share study objectives and request their participation. The HCFs shared their consent to participate in the study by providing official consent over email and nominating 1 sanitary staff or housekeeping staff (responsible for handling the biomedical waste) and 1 supervisor to participate in the telephonic interviews.

As a first step, a pre-test interview was conducted across select HCF staff. After this, the BMWM pictorial guide was disseminated across the study group via email and a dedicated online training webinar was conducted across the same group that aimed to sensitize the study group on how to use the pictorial for the management of regular biomedical waste and COVID-19 waste. The participants who were unable to attend the webinar were provided with the webinar recordings.

The objective was to get the BMWM pictorial guide utilized in the HCF's, as a key resource for the in-house training and capacity building exercises. Three months from the date of dissemination of the pictorial guide (i.e., from the date on which the pictorial was shared over email with each hospital), post-test interviews were conducted. Post-test interviews were aimed to capture the usefulness of the pictorial guide and its access to the participants. The post interview responses were used to capture the change in participants' knowledge, attitude and practices towards biomedical waste management.

Results and Discussion

As per the policy framework governing the healthcare waste management in India, HCFs are required to segregate their BMW into four colour coded categories – yellow, red, white and blue – at its point of generation. All segregated waste is to be collected by an authorised collector or CBWTF operator for the final treatment and disposal. Certain waste items from yellow and red category are needed to be pre-treated through autoclaving or microwaving before handing over to the authorised collector. These include blood bags and microbiological waste. This impact evaluation study assessed and analysed the overall waste management practices across the HCFs.

Category	Type of waste	Treatment/disposal option
Yellow	Human anatomical waste; Animal anatomical waste; Soiled waste; Expired or discarded medicines; Chemical waste; Microbiological, biotechnological and other clinical lab waste; Chemical liquid waste	Incineration or plasma pyrolysis or deep burial
Red	Contaminated waste (Recyclable) tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles) and gloves	Autoclaving/ Microwaving/ Hydroclaving and then sent for recycling. Not be sent to landfill.
White	Waste sharps including metals	Autoclaving or dry heat sterilization followed by shredding or mutilation or encapsulation
Blue	Glassware	Disinfection/ Autoclaving/ Microwaving/ Hydroclaving and then sent for recycling

Table 2. Four colour coded categories of biomedical waste along with their treatment and disposal methods as prescribed in BMWM Rules, 2016. Source: Created by Ananya Tewari, CCDC-CEH.

General observations reported for supervisors and sanitary staff:

All interviewed HCFs were observed to have hospital centric guidelines that are explained by the hospital management to the sanitary staff. These guidelines are used to conduct the regular

training and capacity building sessions for the HCF staff. Printed module, videos and onsite demonstration were the most commonly used methods for providing training to the HCF staff. Even though all interviewed staff reported to have received trainings on biomedical waste management but several of them highlighted the lack of refresher training programmes and that the frequency of training had been affected due to the COVID-19.

Most HCFs stated that they have dedicated posters to provide guidance on BMWM. Segregation and hand washing are the most common aspects depicted in the posters. However, most of the posters were reported to be text heavy or to be covering limited aspects of waste management.

It was observed that all HCFs segregate their waste at source and handover their waste to the authorised collector for final treatment and disposal. Before handing over the waste, all the waste is stored in a secured storage area that consisted of either 1 large storage room or different colour coded rooms for each waste category. Out of the total 11 HCFs, 1 had a captive treatment facility for final treatment and disposal of waste and another one had an onsite incinerator for disposing yellow category of waste. All other waste in the latter facility was handed over to the authorised collector.

As a common practice HCFs use colour coded liners for collection of red and yellow waste categories. Puncture proof containers are used for collecting blue and white waste categories. The intramural transportation of biomedical waste was reported to be conducted using dedicated trolleys. However, during the post surveys, out of 11 HCFs 10 HCFs were found to be following the same practice but one HCF respondent stated that sometimes common or general waste trolleys are also used for intramural transportation of BMW.

All respondents stated that waste bins and trolleys are cleaned on a daily basis using sodium hypochlorite. The other variants that are popularly used for cleaning and disinfection purposes include bacilocid, D125, Spectra, Hospidex and Ecoshield. None of the HCFs were found to be using reusable kits. Some HCFs highlighted that the non-hazardous general waste from office and administrative areas is given to the scrap dealer. Except for 1 HCF, all 10 HCFs were reported to have spill management kits.

Weighing waste after the collection is a common practice across most of the HCFs. After the waste is weighed, each bag is bar coded before handing over to the authorized collector. This helps in maintaining waste data and ensuring the same quantity of waste reaches the CBWTFs. All respondents stated that the staff loads waste manually into the transportation vehicle wearing personal protective equipment.

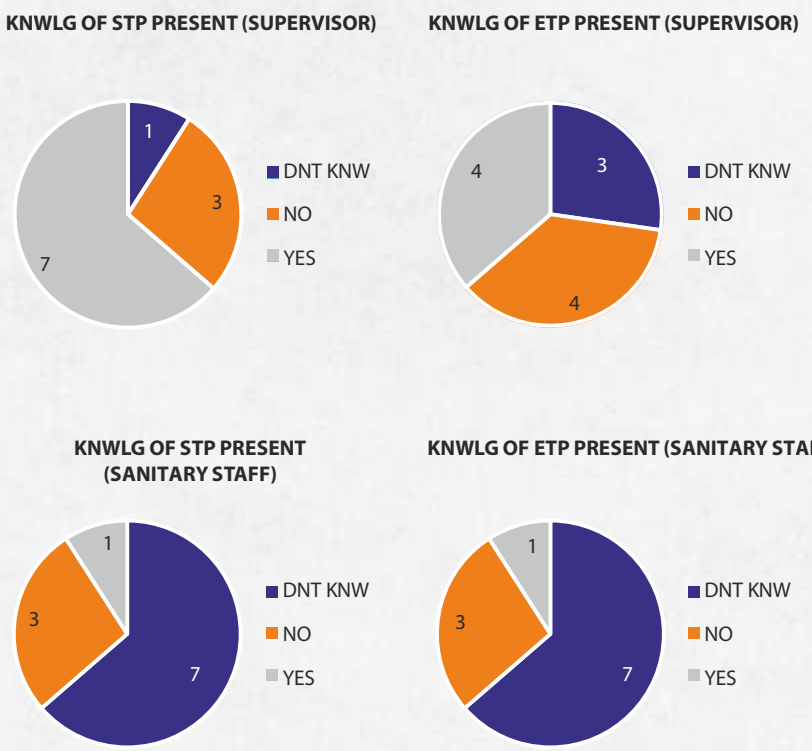
With respect to the pre-treatment of waste categories, blood bags and microbiological wastes were among the most commonly pre-treated wastes (through autoclave) at the HCF level before being handed over to the CBWTFs or the authorised collector. Very few respondents stated about the pre-treatment of sharps and glass waste categories as well. Most respondents stated that they do not pre-treat any blue waste as it is not considered “infectious”.

Pre-surveys revealed that none of the HCFs were storing biomedical waste beyond 48 hours, however during the post surveys one of the respondents stated that they do store such waste beyond the prescribed limit.

Out of the total 11 HCFs, respondents from 10 stated that needle prick injuries are common to

occur amongst their staff while handling BMW within the HCF premises. Nurses were found to be the most common staff to have gotten injured due to needle pricks. The sanitary staff interviews highlighted that 'waste workers' were also prone to get needle stick injuries. All HCFs reported their staff gets immunized against hospital acquired infections.

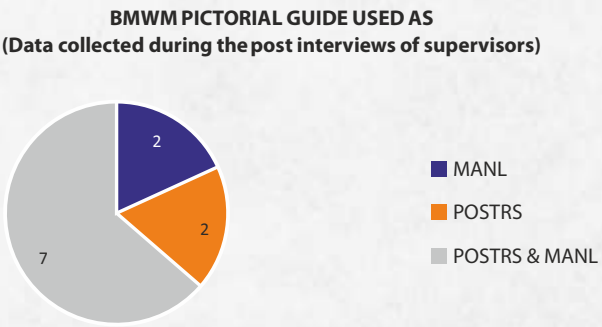
More respondents from supervisor category knew about the presence and use of STP when compared with their knowledge of ETP, situated within the hospital premises. Whereas for the sanitary staff category, less number of respondents had knowledge about the STP and ETP situated within the HCF.



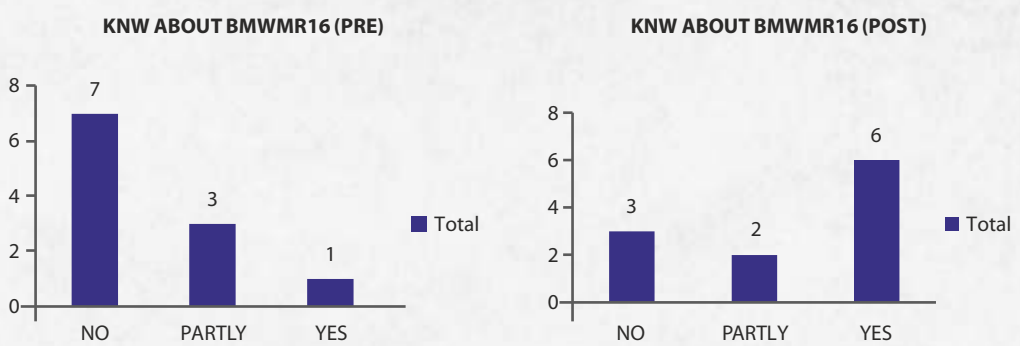
Impact of BMWM pictorial guide on the knowledge, attitude and practices across supervisor category:

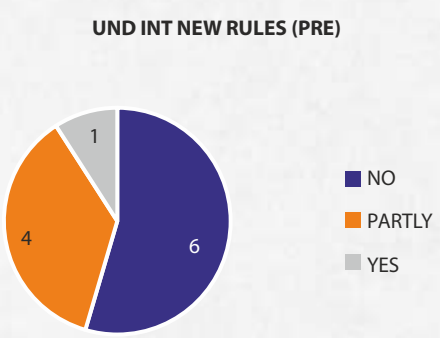
Most respondents stated that the pictorial was used as posters as well as training manual during in-house capacity building sessions. They also stated that it was useful in overall waste handling and waste segregation process.

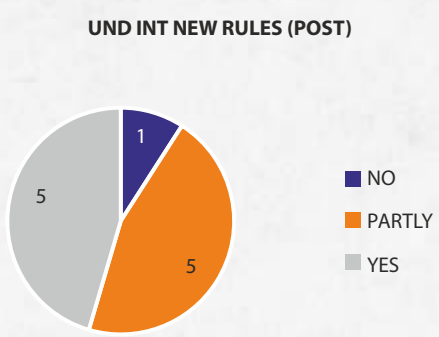
Knowledge of respondents about BMWM Rules of 2016 and its amendments improved among the study group, after the intervention.. Initially 7 of the 11 respondents stated 'No' when they were asked about their knowledge about the rules of 2016 but after the intervention this number dropped to 3, showing a positive change. Initially only 1 respondent knew about the amendments of 2019 and 2018, that were made to the parent rules of 2016, however this number increased to



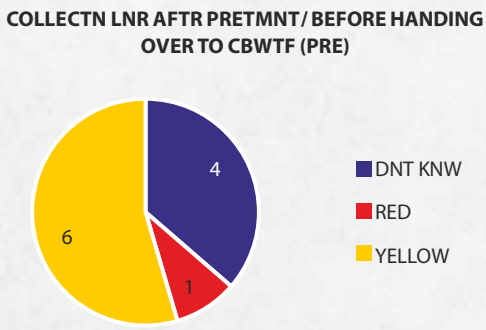
6 after the intervention. The number of respondents who could 'partly' understand and interpret new rules also increased from 4 to 5 and the ones who could completely understand them rose from 1 to 5, post the intervention.

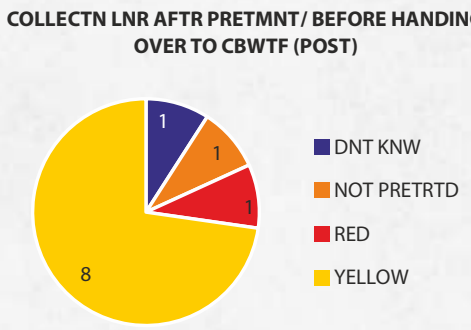




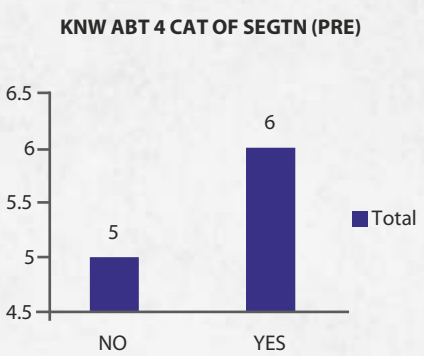


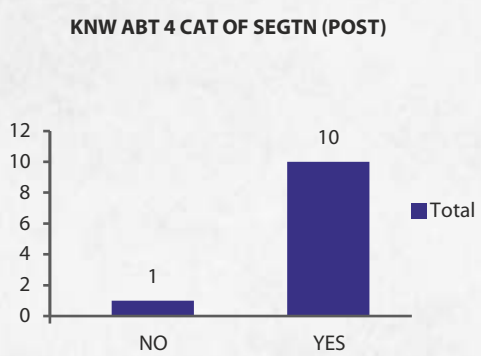
More respondents stated that pre-treated blood bags and microbiological waste was collected in yellow liner. During the post survey, a smaller number of respondents were found to be unaware of the colour of the liner in which pre-treated waste was collected depicting a positive impact on their knowledge since the intervention.



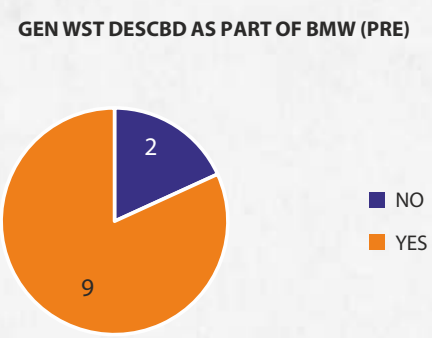


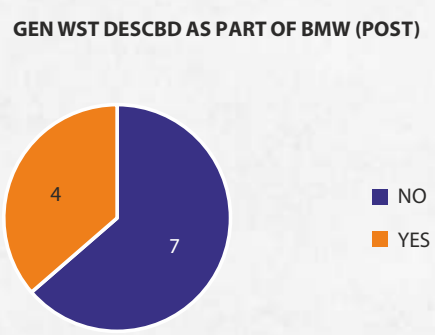
Knowledge about 4 categories for waste segregation significantly improved after the intervention. Initially only 6 people were able to describe about the 4 categories of biomedical waste appropriately. This number increased from 4 to 10 after the use of BMWM pictorial guide by the HCFs.





Before the dissemination of pictorial guide and training intervention, most respondents described general waste as part of BMW however during the post interviews, it was found that the number of such respondents decreased from 9 to 4.



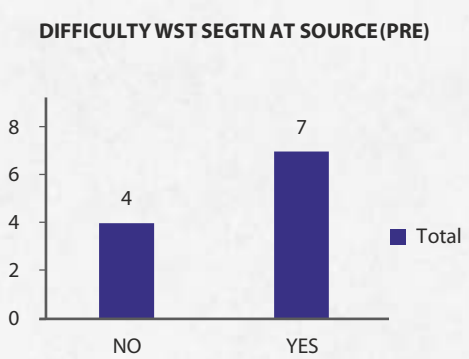


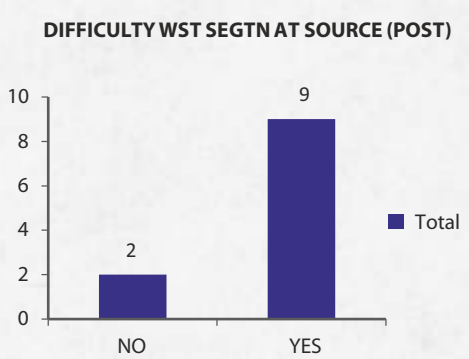
Pre interview results for the frequency of training showed variable responses. The responses provided show that training was conducted on a daily, weekly, monthly, quarterly, half yearly and

on need basis. No trend could be seen for these as almost all segments had equal number of responses. However, the post interview results show an increase in number of respondents who received training on a monthly basis followed by those who got it on a quarterly and weekly basis. Only one respondent said that they received training daily. There could be a possible impact of COVID-19 on the frequency of training as some respondents stated an increase in the frequency and some stated a decrease in the frequency of trainings. More respondents were able to answer 'Yes' when asked about their knowledge about the spill management kits, after the intervention.

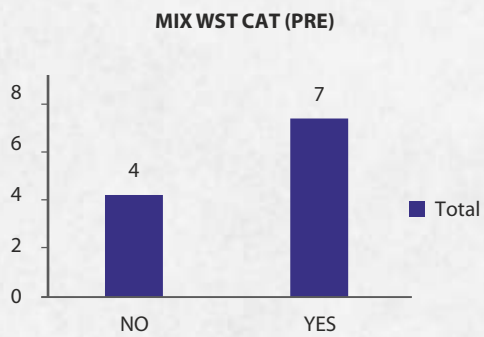
There were a few aspects of waste management that did not show significant impact on the knowledge, attitude and practices adopted by supervisor category. For instance, the data showed that the BMWM pictorial guide and training intervention did not have much impact on the spill management practices/ protocols. However, respondents shared that the pictorial guide was useful in spill management as it acted like a recall poster for the staff.

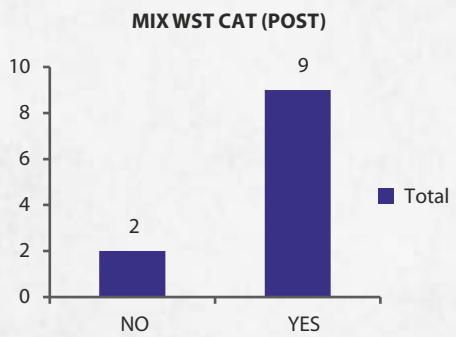
A negative trend was reported regarding the difficulty faced by the respondents while segregating waste at source. The number of respondents who said 'Yes' to this aspect increased after the intervention. The possible reason highlighted by a few respondents was the chaos and panic caused due to the COVID-19 pandemic that resulted in confusion regarding the categories and manner of waste segregation at its source. Some respondents also highlighted that many workers had left the HCF and therefore new staff had to be hired. They had limited knowledge of the waste categories and did not get adequately trained hence were unable to segregate waste at source appropriately.



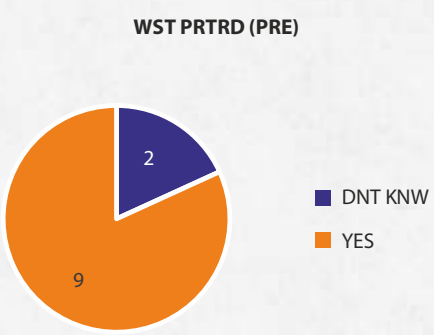


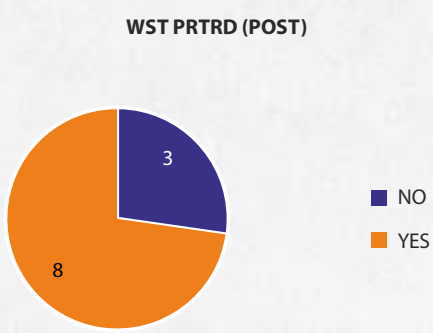
More respondents reported mixing of waste categories while segregation/ collection of waste at its source of generation, during the post interviews. A possible connection to the impact of COVID-19 was highlighted by a few of the respondents during the survey. Confusion regarding the specifications prescribed in the new COVID-19 waste management guidelines was highlighted by few respondents.





No significant change was observed in number of respondents that confirmed the pre-treatment of their waste (as reported during both pre and post interviews), although this number declined by 1 after the intervention. A possible connection with the impact of COVID-19 on the waste management practices can be attributed to this decline. All the respondents across 11 HCFs confirmed that no pre-treatment of any COVID-19 waste was conducted as they considered it to be highly infectious and most workers were scared to pre-treat them onsite (through autoclaving). Most commonly used pre-treatment method was reported to be autoclaving by the respondents.





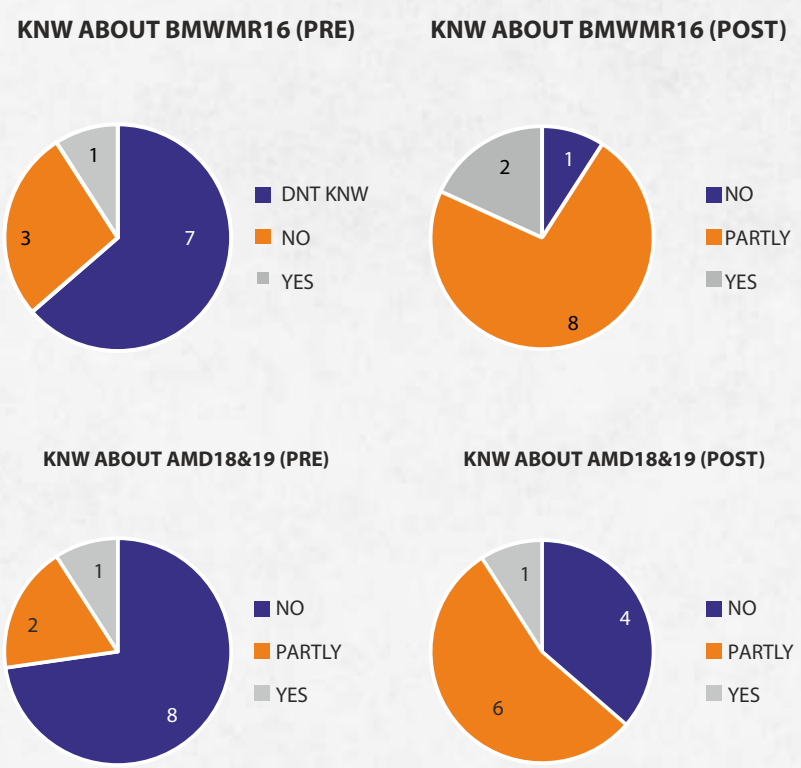
A variable trend was observed during the pre-interviews regarding the type of waste that was given to scrap dealer (data showed a mix of blue category waste, general waste and IV bottles with majority responding that none of the waste was given to the scrap dealer). However, the post interviews revealed that most HCFs do not give their waste to scrap dealer and whatever waste was handed over consisted of the non-infectious general waste category.

Upon specifically asking about the fate of red category waste, a total of 7 respondents stated that it is autoclaved, during the pre-interviews. This number declined to 6 during the post interviews. A possible connection with the impact of COVID-19 can be drawn as some respondents stated a

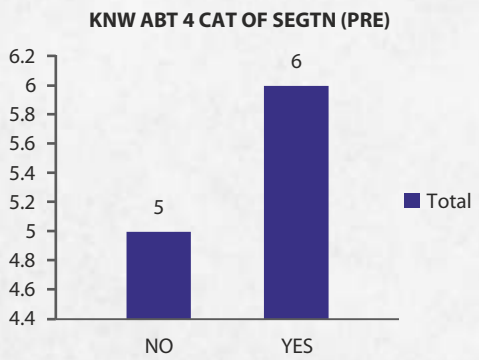
decline in pre-treatment of waste due to the fear of COVID-19 spread.

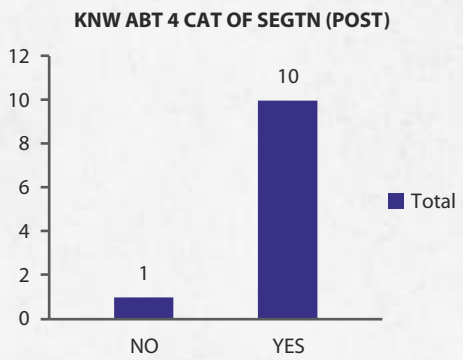
Impact of the BMWM pictorial guide on knowledge, attitude and practices among sanitary staff:

The number of respondents who did not know about the rules of 2016 reduced post the intervention showing positive impact. However, most respondents had limited or partial knowledge of the rules even after the dissemination of pictorial guide. Similar trends were seen for the knowledge of respondents about the amendments of 2018 and 2019.

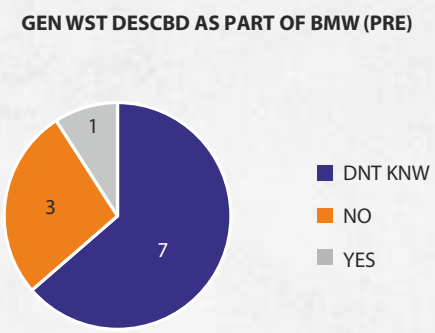


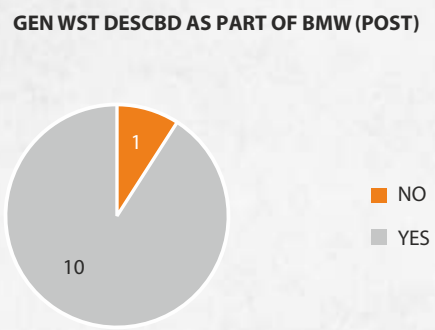
A positive change in number of respondents who were able to understand and interpret new rules was reported during the study as the number of respondents rose from 1 to 2 but the number of people who were not able to understand or interpret the new rules also increased from 6 to 8 after the intervention. The pre survey revealed a variable response to the question of frequency of training provided to the staff. However, the response trends became more consistent post the intervention. Post surveys revealed that more respondents were able to get trained on a monthly basis. Knowledge about the 4 waste categories among sanitary staff improved after the dissemination of pictorial guide.



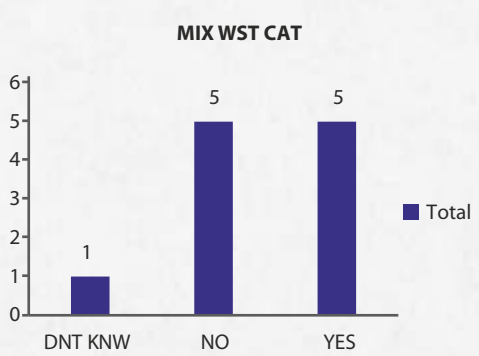


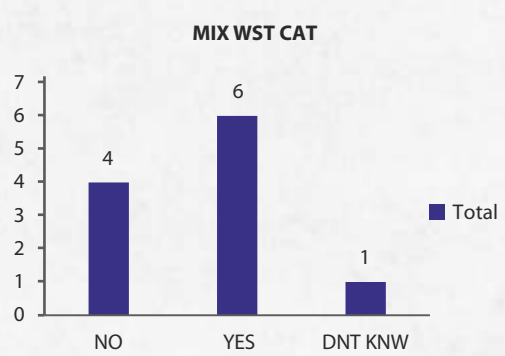
An increase in number of respondents describing general waste as part of BMW was observed after the intervention. However, more number of respondents were able to answer the the question, post the intervention, rather than not knowing about it.



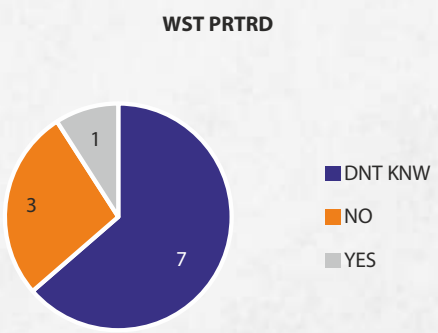


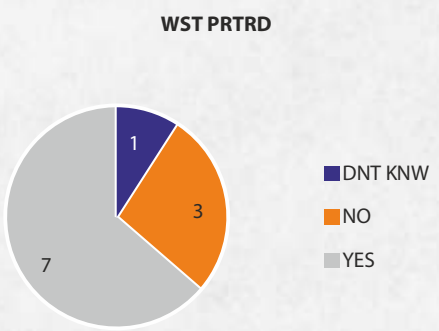
The mixing of waste was reported to have increased after the intervention; respondents stated the confusion among staff due to the pandemic and associated increase in the volume of COVID-19 waste, as the primary reason. Just like the supervisor category, several sanitary staff had left the HCF and had to be replaced with the new members who had limited training in waste management.



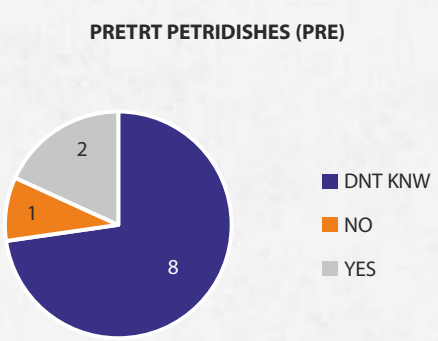


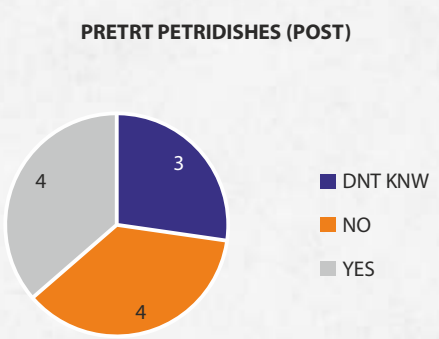
While collecting information on the type of waste that gets pre-treated within the HCFs before handing over to the CBWTFs, more respondents were able to confirm about blood bags and microbiological waste as among the most commonly pre-treated waste categories after the intervention. The number of respondents refusing about the pre-treatment of blood bags increased by 1 after the intervention. One of the respondents stated that the HCF stopped pre-treating the blood bags due to the COVID-19 situation.

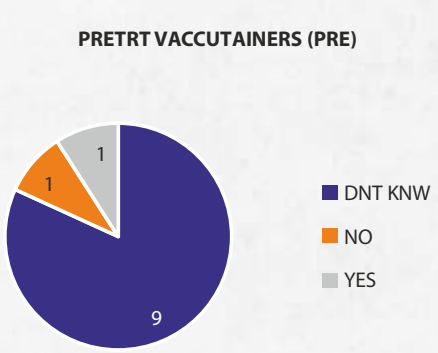


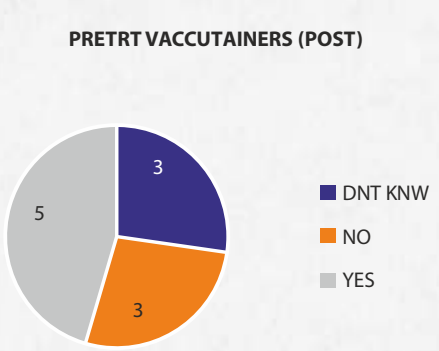


Also, a positive change was reported regarding the knowledge about the pre-treatment of waste among sanitary staff post the intervention. A reduction in number of respondents who did not know about the pre-treatment of petridishes earlier was observed during the post survey. The



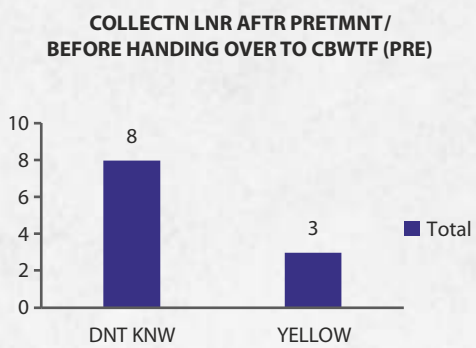


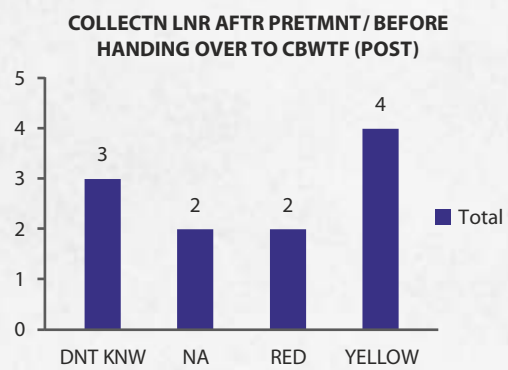


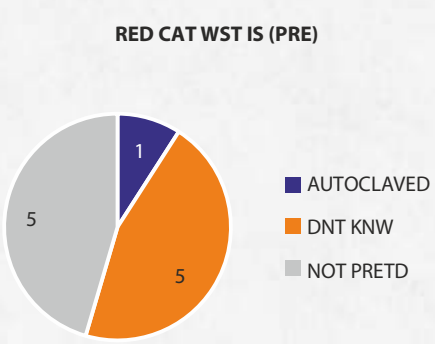


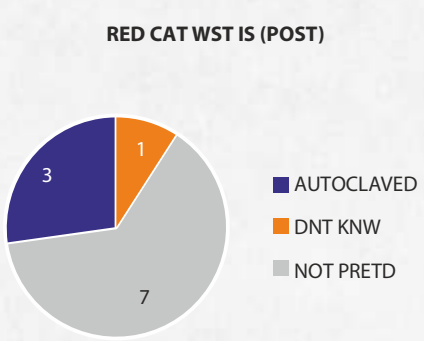
number of sanitary workers who knew about it increased from 2 to 4 during the post surveys, when compared with pre-survey results. The number of respondents stating about lack of pre-treatment of petridishes also increased after the intervention when compared with the data as reported during the pre-survey. This can be attributed to the improved knowledge among the study group who must have become more aware to be able to respond "Yes" or "No" instead of not being aware of the pre-treatment process at all. Similar trends can be observed for their knowledge about pretreatment of vaccutainers.

Knowledge of sanitary staff improved about the pre-treatment of red waste category after the intervention as more candidates were able to describe the colour of collection liner used to collect pre-treated waste during the post interviews when compared to the numbers reported during the pre-surveys.

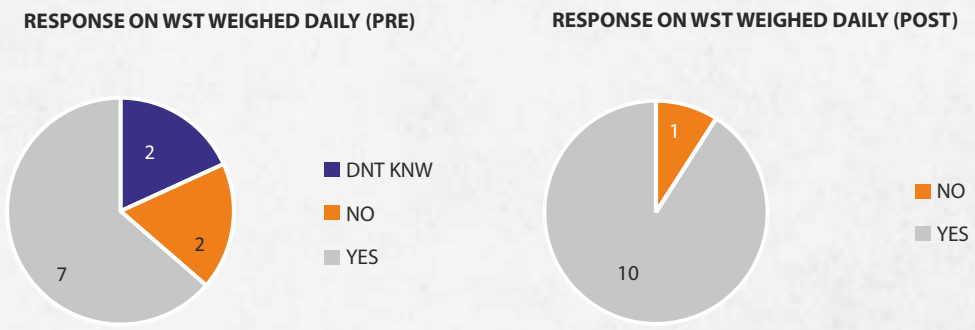








The number of respondents who stated that red category waste was pre-treated increased from 1 to 3 after the intervention. The number of people who did not know about the fate of red waste decreased during the post survey. However, the number of respondents who stated about the red waste category not being pre-treated is seen to increase from 5 to 7 during the course of surveys. This may also be attributed to the improvement in their knowledge levels as they were better able to answer the question post intervention.



More respondents stated about weighing waste after the intervention as this number rose from 2 to 10.

Conclusion

The results reveal that the pictorial guide developed by CCDC-PHFI had a positive impact on the knowledge, attitude and practices of biomedical waste management across both sanitary staff and supervisor categories. However, the data shows that supervisors had a better understanding of the waste management practices and associated policy updates when compared to that among the sanitary staff. Knowledge about the biomedical waste management rules and its amendments, its interpretation, understanding of the 4 categories of waste segregation were among the aspects that saw a positive change across the supervisor category. Similar trends were observed for the sanitary staff category about their knowledge of policy guidelines and waste segregation categories but they had only partial understanding of the rules and amendments, unlike the supervisor category which could be because of language difficulties in understanding the pictorial guide.

Certain areas were reported to have negative or no impact of the intervention among the supervisor category. This included difficulty while segregating waste at source and increased incidences of waste mixing across both the categories. The mixing of waste was reported to have occurred due to the confusion among waste handling staff during COVID-19 as they were not clear about the protocol to be followed and the appointment of new staff who had to be hired in place of those who left their positions due to the risk of infection or COVID-19 illness. Some respondents stated the mixing of waste and its subsequent sorting that usually is conducted manually, as being the primary reason for needle prick injuries among staff.

Similarly, not much change was reported while documenting the practice of the pre-treatment of waste among supervisor and sanitary staff categories, instead respondents revealed that none of the COVID-19 associated waste was being pre-treated. Also, a declining trend was reported for pre-treatment of red category waste due to the fear of COVID-19 spread while handling the waste.

However, it is important to note that even with these declining trends, a greater number of sanitary staff were able to provide definite answers about the fate of petridishes, vaccutainers and the practice of waste weighing, post the intervention, rather than stating that they were not aware of the practices at all. The results for both supervisor and sanitary staff also revealed that the frequency of training and refresher trainings were reported to be impacted due to the pandemic.

It can be concluded that improving the frequency of Refresher Training Programmes and sensitizing the workers about safe handling of regular biomedical waste and COVID-19 waste is essential. In cases of introduction of new waste handling protocols, dedicated training programmes need to be conducted to clarify the procedures and sensitize the communities. It will not only improve the waste segregation but will also reduce the risks of waste mixing and subsequent needle stick injuries that occur during manual sorting. Constant supervision at each level of waste management during the peaks of COVID-19, may improve the overall waste handling situation and prevent spread of infections among health workers. A more dedicated approach is needed to sensitize the sanitary staff about the hazards of biomedical waste and its safe handling.

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