# Awareness, attitude and practises of biomedical waste management amongst public health-care staff in Karnataka, India

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## Abstract

**Purpose** – Enormous amount of biomedical wastes (BMW) produced everyday across the world. Management of BMW depends on adherence to protocol. BMW management at generation point, definitely, depends upon the awareness, attitudes and practises of health-care staff, the purpose of this study will assess the awareness, attitude and practise regarding different aspects of BMW.

**Design/methodology/approach** – An observational with appropriate checklists, and a cross-sectional study, involving questionnaires, was conducted during 7-24 January 2016. The existing system of BMW management, funds, resources, etc., knowledge, attitude and practises about BMW were assessed amongst 273 health-care workers in selected public health-care institutes of Karnataka.

**Findings** – Of 273 study participants, majority (54%) of them have not received any training pertaining to BMW. The results showed a poor level of knowledge and awareness of BMW management amongst health-care personnel. Merely, 43% of the participants correctly knew the categorization of BMW and its disposal in proper colour-coded bins/bags. Awareness is very poor amongst the lower age group, male participants, lab-technicians/pharmacists and supporting staff. Doctors were good at theoretical knowledge such as rules, legislation and public-health importance of BMW management than the practical aspects such as categorization and colour-coding. Further, the attitude of health-care staff is favourable about BMW. Immunization for hepatitis-B was very poor amongst waste handlers (43%).

**Originality/value** – As the awareness and practise regarding BMW management were poor across different health-care staff there is a need to conduct periodic training and regular monitoring with special focus on the proper use of personal protective equipment. Further, precautionary immunization should be provided, especially waste handlers and sanitary workers.

**Keywords** India, Practise, Knowledge, Hospital, Biomedical waste, Health-care staff

**Paper type** Research paper



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## Introduction

Biomedical waste (BMW) is waste generated during diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto, or in the production and testing of biological. In addition, this BMW is contaminated with human fluids (Das *et al.*, 2001). It has been documented that the waste produced in the course of health-care activities carries a higher potential for infection and injury than any other type of waste (Park, 2011). The following BMW comprises of: sharps, which (if improperly segregated) could become agents for the spread of deadly diseases such as HIV-AIDS, hepatitis B and C infections (Ananth *et al.*, 2010); human and animal tissues, which also harbour many pathogenic micro-organisms in addition to those mentioned above; cytotoxic wastes, as well as recyclable wastes like soiled or unsoiled plastic and rubber items, which (if inappropriately disposed) could have an adverse impact on ecological balance (Lakshmikantha, 2006; Misra and Pandey, 2005).

It is documented that though, throughout the world biomedical waste management is practised poorly, but it got its attention very recently (Babu *et al.*, 2009) and that too because of increased awareness of HIV/AIDS (Kumar *et al.*, 2015). A number of studies have indicated that the inappropriate handling and disposal of health-care waste poses health risks to health workers who may be directly exposed and to people near health facilities, particularly children and scavengers who may become exposed to infectious waste and a higher risk of diseases such as Hepatitis and HIV/AIDS (Sawalem *et al.*, 2009; Adegbita *et al.*, 2010; Coker *et al.*, 2009; Path, 2009; Oke, 2008; WHO, 2014).

Various biomedical procedures will create enormous amounts of hazardous and infectious wastes in hospitals everyday across the world. It is estimated that India alone produces about half a million tons of hospital waste annually with the generation rate of 0.5 to 2.0 kg per bed per day (Patil and Shekdar, 2001). Approximately, 10%-25% of the total BMW is hazardous and can be injurious to humans or animals and detrimental to the environment (Shalini *et al.*, 2012; WHO, 2013). It is important to realize that though the amount of hazardous BMW is less than one-fourth of total BMW if it does not segregate and treated properly, the whole waste becomes harmful (Singh *et al.*, 2007). Hence, the objective of biomedical waste management mainly involves prevention of disease transmission from one patient to other; to health workers from patients and vice versa; prevention of injury to the workers in health-care units and workers involved in support services (Pasupathi *et al.*, 2011; Joseph *et al.*, 2015).

### *Rationale*

Proper management of BMW depends on adherence to protocol at the health-care facility level, investment in and implementation of disinfection, recycling and disposal at the terminal site (Pattnaik and Reddy, 2010). However, the success of the later steps depends on initial processing i.e. the one done at the point of generation, in health-care facilities, in the first place (Ananth *et al.*, 2010), the quality of which, definitely, depends upon the awareness, attitudes and practises of the various health-care professionals working therein (Mathur *et al.*, 2011). Thus, the right knowledge, a positive attitude and good practise are imperative to guide and serve the patients (Jain *et al.*, 2010; Sanjeev *et al.*, 2014) and protect themselves from exposure to potentially hazardous substances (Adogu *et al.*, 2014).

The biomedical waste (management and handling) Rules, 1998 provides well-established protocols for handling and management of BMW. These rules mandate health-care facilities to segregate, disinfect and dispose of BMW in a manner, which protects the safety of health-care professionals, as well as that of the environment (Misra and Pandey, 2005; Park, 2011). Hence, by the implementation of the biomedical waste management rules 1998, every

concerned health personnel is expected to have proper knowledge, practise and capacity to guide others for waste collection and management and proper handling techniques (Yadannavar *et al.*, 2010). However, evidence suggests that gaps in knowledge and lacunae in attitudes and practises are still prevalent to a worrying extent amongst the various categories of health-care professionals in India (Pattnaik and Reddy, 2010; Verma *et al.*, 2008; Kumar *et al.*, 2009; Pandit *et al.*, 2005; Rao, 2008; Kishore *et al.*, 2000).

Keeping in view the above scenario, the present study will try to understand the existing practises of BMW management and assess the awareness, attitude and practise regarding different aspects of BMW and its management amongst staff of public health-care institutions in selected districts of northern Karnataka.

## Methods and materials

### *Ethics*

The study was approved by the Ministry of Health and Family Welfare (MoHFW), Government of India, New Delhi. In addition to that, necessary administrative approvals were obtained from competent authorities at the district level and at visited health facilities before conducting the study. Further, oral consent was taken from each of the interviewed respondents.

### *Study design and area*

The present study was conducted in selected districts of Northern Karnataka [1]. Out of the total 15 districts [2], three districts were selected, namely, Uttar Kannada, Belgavi and Gadag and the cross-sectional survey has been conducted to collect data for the present study. Considering the financial and time constraint, these districts have purposively selected. Proper care has been taken to select the districts, which carry more or less the same status in health indicators.

Further to understand biomedical waste management (BMWM) at different levels of health-care facilities, One district hospital (DH), two sub-divisional hospitals (SDHs), two community health centres (CHCs) and two Primary Health Centres (PHCs) have been covered from each of the above-selected districts. Hence, at district level one DH has been covered in each district. Further, two tehsils [3] from each district have been selected purposively where at least one SDH, one CHC and one PHC are available than from each tehsil one SDH, one CHC and one PHC have been covered. Hence, finally, the survey was conducted from overall 21 health-care facilities including three DHs, six SDHs, six CHCs and six PHCs, which have been covered and data collection was conducted.

### *Sample size and data collection*

Two strategies have been adopted to achieve the study objectives. Firstly, the discussion has been held with the district health-care waste management consultant, a district-level in-charge for BMWM, to understand existing practise, provision of human resources and training, the supply of materials and disposal system regarding BMW in the district. In addition, a medical officer (MO)/staff nurse looking after BMWM of the selected facilities were interviewed to obtain necessary information and their views on BMW using the pre-designed guideline.

Secondly, interviews have been conducted to assess the level of awareness, attitude and practise of BMWM amongst health-care personnel such as doctors, nurses, lab-technicians (LTs), pharmacists and waste handlers/supporting staff of public health-care facilities, in the selected, DHs, SDHs, CHCs and PHCs. In each facility especially in DH and SDH different departments have been covered to employee respondents. Finally, the sample consisted of

273 respondents as follows: 29 Doctors, 177 Nurses, 23 LTs/pharmacists and 44 waste handlers/supporting staff. Staff present during our visit was invited individually to participate in the study after giving informed consent. All, the study participants were assured about their confidentiality and anonymity.

The information was obtained from the respondents through a pre-designed and pre-tested questionnaire with both open and close-ended questions. The questionnaire includes the details of various professional, socio-demographic variables such as age, sex, educational status, working experience, type of work, religion, caste and other details regarding awareness, attitude and practise for BMW handling and its management. Further, observational checklists were used to collect data related to the existing system of BMW, training of health-care staff, funds for MBW, resources and process of BMW, segregation and final treatment of BMW. Firstly, the data collection tools were prepared in English and then translated into the Kannada language. Moreover, before starting the actual data collection process, the tools were piloted on other than sampled health facilities and health-care staff. Trained professionals with vast experience in survey research and data collection were conducted in the data collection process. The data collection for the study was conducted during 7th-24th January 2016.

*Data quality*

Data collection tools were translated into the Kannada language, and to assure the consistency of the translation investigators were rechecked the translation and corrections were done as appropriate. The pre-test was done on non-sampled health facilities and health-care staff. Some slight modifications were done in the data collection tools on the basis of the pre-test results. Further, investigators were given appropriate training for conducting data collection from the selected health facilities and health-care staff. During the data collection process, questionnaires and observational checklists were checked for completeness and the necessary field edit was done.

*Analysis plan*

Cross-sectional survey data collected through personal interviews from selected health-care facilities have been entered using The Census and Survey Processing System software version 5.0 and converted to Statistical Package for Social Sciences (SPSS) software. A variable on the awareness of health-care staff regarding different categorization of BMW was computed. There are five categories of BMW, the respondents were asked for all the categories separately. To assess the correct picture of awareness, all responses are clubbed in to one variable and who have responded correctly for each of the five categories has been put as "yes", which means correct for all categories. In addition to univariate and bivariate techniques, $\chi^2$ test of significance has been applied and $p$-values of $<0.001$, $<0.01$ and $<0.05$ were considered to observe statistically significant association between a dependent variable and predictor variables. Descriptive statistics like proportion and frequency were computed as appropriate, and finally, the results of the study were presented in the form of tables and texts as appropriate. All, analysis has been carried out in SPSS version 20 software (IBM Corp, 2011).

## Results and discussions

*Existing system of biomedical waste management in the visited health facilities*

In addition to the cross-sectional survey amongst health-care staff in selected government health-care facilities, the details regarding BMWM in each visited health-care facility have been gathered using a pre-designed guideline/checklist to have a broader idea regarding the resources and process of BMWM existed in the health-care institutes. The details gathered through observation and discussion with staff during the field survey are given below.

*Training regarding biomedical waste management.* Training of health staff regarding BMWM is very crucial in handling and management of BMW. In the selected district, the training status of health-care staff on BMW management was very poor, as such there is no regular training on the topic and somehow very few staff has been received hands-on training. In each district, about four to five staff have received training of trainers on BMWM, but they yet to provide training to other staff. Though, the district health-care consultants are providing some hands-on sessions while their visits to the health facilities, but, this is not enough to understand the sensitivity of the BMW. The data collected through interviews with health-care staff revealed that more than half of the staff have not received any of the formal training for the management BMW.

*Fund for biomedical waste management.* As the management of BMW is required significant funds for training, procurement of resources, outsourcing with common treatment facility (CTF), etc., hence, proper financial flow is very important. However, staff opined that as such there is no separate financial budget for the same. The health facilities are managing it using funds from the common grants to the health facilities i.e. annual maintenance grant. [When discussed the issue with the staff, they opined that there is no clear cut guidance even for utilization of the common fund for the purpose, hence, they are a bit confusing to the same].

*Resources and process of biomedical waste management.* In all three selected districts, the segregation process is being carried out at all levels of health-care facilities. Though the system of segregation is available in all facilities, the observation revealed discrepancies across all visited facilities generally and particularly in those where resource allocation was poor. Resources for segregation and in-house transport (colour-coded bins and bags, trolley, personal protective equipment (PPEs) and display of charts, etc.) of BMW along with a proper system for storage were very poor across all types of health facilities. Discussion with the staff revealed that more than 50% of all health facilities had one or other problems in resources for segregation, sharps management, in-house transport and storage. As discussed earlier, neither there is a separate fund nor clear cut guidance for the utilization of funds from the common grants for BMWM, hence, there is confusion amongst facility in-charge in indenting and procurement of resources for BMWM.

Observation also revealed that colour-coding for various categories of waste is not properly followed by some nursing staff in the visited facilities. There may be many reasons for that; firstly, the lack of training regarding BMW amongst staff working in health facilities; secondly, shortage in supply of colour-coded bags and containers; and third, the charts pasted by different agencies are also creating confusion, as in some charts four categories of BMW has shown instead of five according to BMW rule 1998 [Ministry of Environment and Forests (MoEF), Government of India, 1998].

*Segregation of biomedical waste.* All facilities, including PHCs, are following segregating of the BMW at the place of origin. Physical observation revealed that though, the system of segregation is available at each visited facility, but discrepancies were found in the majority of the facilities (14 out of 21) in segregating the BMW. Like, they putting the waste of one category items in other category colour-coded bags. Similarly, one category items are mixing with other category and general garbage is also putting in the colour-coded bag assigned for other categories of BMW.

*Final treatment of biomedical waste.* All facilities, up-to PHCs level, have been tie-up with CTF except UK district, where only DH, SDHs and Urban Health Facilities (UHCs) have tied-up, whereas, PHCs were using deep burial and sharp burial pits available in their premises. Though the CTF is available in each district some discrepancy in the removal of BMW was observed. In some facilities, especially, which are located far away from CTF, the waste is removed once or twice a week. Mainly UK district, where the CTF newly established, was suffering from the

timely removal of BMW. District in-charge discussed the reasons for that as follow; firstly, the district is having a very wide geographical coverage; hence, transportation from one end to another end will take a lot of time. Secondly, the CTF is newly established they yet to improve their agency, especially in terms of vehicles and manpower for transportation of BMW.

*Perception of staff to improve biomedical waste management.* The perception regarding improvements in the system of BMWM was gathered from staff who is looking after the BMWM. All, in-charge officers of BMWM at visited health facilities and nodal district officers strongly expressed that there is a need for building systems capacity [4] and higher resource allocations [5] if BMWM was to improve across health facilities. Similarly, a significant proportion of in-charge of BMWM also emphasizes streamlining of processes [6] and improved governance [7].

*Analysis of cross-sectional survey data*

The distribution of the profile of the respondents who participated in the study has presented according to background characteristics in Table 1. Results reflect that there is a larger share of respondents in the group of less than 40 age in the sample (69%) as compared to 40 or more years age group (31%). With regard to the classification on the basis of sex, the majority (79%) of the respondent are women compared to their counterparts (21%). The religious compositions of the study population mirror that, majority of the respondent belonging to Hindu (86%) and the rest to the others (14%). Similarly, the caste composition reflects the highest proportion of respondents belongs to OBCs (45%), followed by other castes (30%) and SCs/STs (25%). Further, the study population more or less equally distributed, one-third each, overall three districts, respectively. Around half of the health-care staff has been recruited from DHs (51%) for the present study, followed by SDHs (30%) and the remaining 19% from lower health facilities such as CHCs and PHCs. The study included different health-care staff, around 64% of them are nurse, followed by 16% sanitary staff, 11% Doctors and eight per cent LT/Pharmacists. The majority of the respondent (80%) have more than five years of experience in the health-care services. Further, around 57% of the study population was permanent health-care staff and 46% have received training regarding BMW.

Information is gathered in the survey to know the "correct" knowledge of BMW categories and colour-coding to be used for BMWM. Table 2 presents the distribution of health-care staffs' awareness regarding the correct categorization of BMW by background characteristics. Here the awareness of health-care staff regarding different categorization of BMW clubbed in one variable and who have responded "correctly" for each of the five categories has been put as "yes", which means correct for all categories. Results indicate that awareness of correct categorization of BMW and its proper colour-coding disposal was poor amongst all categories of public health-care personnel, that only 43% of the total study participants correctly knew the categorization of BMW and its disposal in proper colour-coded bags. Analysis of awareness by different background characteristics reveals that, as age increases the level of awareness also increases, only one-third of the respondent in the age group of 20-29 years are aware compared to 43% in the age group of 30-39 years, 51% in 40-49 years and 53% amongst the age group of 50 years and more. Awareness level is more amongst female (45%) health-care staff than their counterpart (36%). The knowledge is better amongst the respondents who are belonging to other religious communities (Christian and Muslims) (49%) than the respondents belonging to the Hindu religion. Similarly, analysis by the social caste group reveals that awareness is better amongst the general caste group (45%) followed by OBC (44%) and SC/ST (39%).

Amongst the three study districts, health personnel in the UK district have better knowledge (54%) of different categorization of BMW followed by Belgavi (45%), Gadag

| Background characteristics | (%) | No. of cases |
|---|---|---|
| *Age* | | |
| 20-29 years | 29.3 | 80 |
| 30-39 years | 39.6 | 108 |
| 40-49 years | 18.7 | 51 |
| >=50 years | 12.5 | 34 |
| *Sex* | | |
| Male | 21.2 | 58 |
| Female | 78.8 | 215 |
| *Religion* | | |
| Hindu | 86.4 | 236 |
| Others | 13.6 | 37 |
| *Caste* | | |
| SC/ST | 24.5 | 67 |
| OBC | 45.4 | 124 |
| Others | 30.0 | 82 |
| *District* | | |
| Uttar Kannada | 34.1 | 93 |
| Belgavi | 33.3 | 91 |
| Gadag | 32.6 | 89 |
| *Type of facility* | | |
| DH | 50.5 | 138 |
| SDH | 30.0 | 82 |
| CHC/PHC | 19.4 | 53 |
| *Designation* | | |
| Doctors | 10.6 | 29 |
| Nurses | 64.8 | 177 |
| Pharmacists/technicians | 8.4 | 23 |
| Sanitary staff | 16.1 | 44 |
| *Years of experience* | | |
| <One year | 4.8 | 13 |
| One – four years | 15.8 | 43 |
| Five – nine years | 39.6 | 108 |
| >=10 years | 39.9 | 109 |
| *Nature of employment* | | |
| Permanent | 56.8 | 155 |
| Contractual | 43.2 | 118 |
| *Training received* | | |
| Yes | 45.8 | 125 |
| No | 54.2 | 148 |
| Total | 100 | 273 |

**Notes:** SC = scheduled caste; ST = scheduled tribe; OBC = other backward class; DH = district hospital; SDH = sub-divisional hospital; CHC = community health centre; PHC = primary health centre

**Table 1.** Percent distribution of health-care personnel by background characteristics

(29%), which is statistically significant ($p = 0.003$). Analysis by type of facility shows that the staffs are more aware in the SDH and lower-level hospitals than the DH. It may due to the extent of handling all categories of waste is more frequent in lower level facilities as there are less number of staff available and the same staff will work in all sections of the facility. While at DH the number of staffs are more and deputed to separate sections, hence, they are less likely to handle with all type of wastes frequently. Similarly, amongst all four

| Background characteristics | Yes% (*n*) | No. of cases | *p*-value |
|---|---|---|---|
| *Age* | | | |
| 20-29 years | 33.8 (27) | 80 | 0.139 |
| 30-39 years | 42.6 (46) | 108 | |
| 40-49 years | 51.0 (26) | 51 | |
| >=50 years | 52.9 (18) | 34 | |
| *Sex* | | | |
| Male | 36.2 (21) | 58 | 0.158 |
| Female | 44.7 (96) | 215 | |
| *Religion* | | | |
| Hindu | 41.9 (99) | 236 | 0.277 |
| Others | 48.6 (18) | 37 | |
| *Caste* | | | |
| SC/ST | 38.8 (26) | 67 | 0.724 |
| OBC | 43.5 (54) | 124 | |
| Others | 45.1 (37) | 82 | |
| *District* | | | |
| Uttar Kannada | 53.8 (50) | 93 | 0.003 |
| Belgavi | 45.1 (41) | 91 | |
| Gadag | 29.2 (26) | 89 | |
| *Type of facility* | | | |
| DH | 40.6 (56) | 138 | 0.703 |
| SDH | 46.3 (38) | 82 | |
| CHC/PHC | 43.4 (23) | 53 | |
| *Designation* | | | |
| Doctors | 41.4 (12) | 29 | 0.011 |
| Nurses | 49.2 (87) | 177 | |
| Pharmacists/technicians | 17.4 (04) | 23 | |
| Sanitary staff | 31.8 (14) | 44 | |
| *Years of experience* | | | |
| <One year | 15.4 (02) | 13 | 0.068 |
| One-four years | 32.6 (14) | 43 | |
| Five-nine years | 47.2 (51) | 108 | |
| >=10 years | 45.9 (50) | 109 | |
| *Nature of employment* | | | |
| Permanent | 48.4 (75) | 155 | 0.023 |
| Contractual | 35.6 (42) | 118 | |
| *Training received* | | | |
| Yes | 48.0 (60) | 125 | 0.212 |
| No | 38.5 (57) | 148 | |
| Total | 42.9 (117) | 273 | |

**Notes:** SC = scheduled caste; ST = scheduled tribe; OBC = other backward class; DH = district hospital; SDH = sub divisional hospital; CHC = community health centre; PHC = primary health centre; $\chi^2$ = Pearson chi-square test at 5% significance level

**Table 2.**
Percent distribution of respondent's awareness regarding "correct" categorization of BMW by background characteristics

categories of the health-care staff, nursing staff have better knowledge (49%) than the doctors (41%), waste handlers (32%) and LTs/pharmacists (17%) and differences are statistically significant ($p = 0.011$). Like age, the years of experience is also showing positive association, as years of experience increases the awareness of health-care staff is also increases. Only 15% of the respondent who has less than one year experience are aware

compared to 47% who have five–nine years of experience. The staff who are working on a contractual basis (36%) were having poor knowledge than permanent staff (48%), which is statistically significant ($p$ = 0.023). Likewise, who have received training on BMWM expectedly more aware than their counterpart, but this is statistically not significant (Table 2).

Table 3 shows the distribution of respondents' awareness regarding the categorization of BMW separately for each category by professional characteristics. Results indicate that awareness on segregation was high especially for categories such as infected plastic waste (92%) and soiled waste (91%). Moreover, 63%, 80% and 72% of the study participants identified that general, infectious and sharp wastes should be disposed of in a black, yellow and a safe box, respectively. Further, the knowledge of doctors and nursing staff do not differ much between each category, whereas the difference in awareness between LTs/pharmacists and waste handlers exists. Hence, interestingly LTs/pharmacists' awareness about anatomical waste is poor (39%), while; the same proportion (39%) of waste handlers were able to respond correctly for non-infected waste. It could be due to the nature of the work they perform as they were less likely to handle this category of BMW. The working experience is also an important factor for determining the level of understanding amongst health-care staff about the BMW segregation. Especially, who have up to 10 years of experience they have a better understanding regarding each category compared to other staff. Though the awareness about non-infected waste is low in general, even amongst experienced staff, compared to other categories of waste, but it is worst amongst those who have less than one year of experience. The health-care staff, working on permanent pay role fairly aware compared to those who are on a contractual basis. Similarly, those who have received training are having a better understanding than their counterpart.

Responses of the study participants to the knowledge-based questions on BMWM have been presented in Table 4 according to the designation of the respondent. About 47% of the respondents considered all health-care wastes are hazardous. Interestingly, waste handlers (41%)

**Table 3.** Percent distribution of respondent's awareness regarding the correct categorization of BMW by professional characteristics

| Professional characteristics | Categories of biomedical waste (colour-coding) | | | | | |
|---|---|---|---|---|---|---|
| | Non-infected waste (black) | Soiled waste (red) | Anatomical waste (yellow) | Infected plastics (blue) | Sharps (white) | No. of cases |
| *Designation* | | | | | | |
| Doctors | 62.1 | 75.9 | 65.5 | 75.9 | 69.0 | 29 |
| Nurses | 70.1 | 94.4 | 87.6 | 96.0 | 75.1 | 177 |
| Pharmacists/ technicians | 56.5 | 78.3 | 39.1 | 69.6 | 65.2 | 23 |
| Sanitary staff | 38.6 | 93.2 | 79.5 | 100.0 | 65.9 | 44 |
| *Years of experience* | | | | | | |
| <One year | 23.1 | 76.9 | 69.2 | 84.6 | 76.9 | 13 |
| One–four years | 48.8 | 93.0 | 83.7 | 95.3 | 67.4 | 43 |
| Five–nine years | 67.6 | 92.6 | 80.6 | 88.9 | 70.4 | 108 |
| >10 years | 68.8 | 89.9 | 78.9 | 95.4 | 75.2 | 109 |
| *Nature of employment* | | | | | | |
| Permanent | 71.6 | 92.9 | 81.3 | 94.8 | 74.2 | 155 |
| Contractual | 51.7 | 88.1 | 78.0 | 89.0 | 69.5 | 118 |
| *Training status* | | | | | | |
| Yes | 68.8 | 94.4 | 85.6 | 96.0 | 71.2 | 125 |
| No | 58.1 | 87.8 | 75.0 | 89.2 | 73.0 | 148 |
| Total | 63.0 | 90.8 | 79.9 | 92.3 | 72.2 | 273 |

responded fairly, etc. Only 46% of the staff has received any training for BMWM and the proportion who received training is more amongst nursing staff (49%) and lowest amongst doctors (31%). The awareness regarding the existence of BMWM rule, years of enactment and the agency, which implement the rule has been gathered in the study. Around 72% of the respondent are aware about the existence of the BMWM rule, the doctors (86%) fairly know about it and closely followed by nursing staff (81%), LTs/pharmacists (78%) and merely 21% of waste handlers know about it. Similarly, the knowledge about the year of enactment (8%) and the agency, which implement the rule (10%) was very poor amongst study respondents. when asked about the correct number of the colour-coded bags/container to be used, approximately, little more than three-fourth of the respondent have given correct response. Only two-thirds of the study participants were identified the universally accepted bio-hazard symbol, little more than one-fifths was aware about the maximum storage time of hazardous waste i.e. 48 h. Knowledge regarding the risk of diseases transmitted through improper management BMW was adequate in all four categories of health-care staff.

Table 5 present the distribution of health-care personnel's attitude towards BMWM. Results show that cent percent of the study participants believed that, knowing about generation, hazardous and legislation of BMWM was very important. In the same way, they believe BMWM is an issue of concern; it should be segregate at the point of origin, it is necessary to wear PPE while practicing and proper disposal of BMW that was generated by them as part of their responsibility. Around 14% of the health-care staff think that the safe management of BMW will increase the financial burden of the hospital and doctors (35%) were more to feel like that. Similarly, 11% of the respondents believe that the safe management of BMW is an extra burden of work. Though, the majority of participants (80%) believe that they have some knowledge on BMWM, but still there was a felt need for training from most of the study participants (90%).

Percent distribution of study participant's responses on practise-based questions according to their designation is presented in Table 6. About 71% agreed that the institute they were working in had a tie-up with waste management companies for final treatment of BMW. More number of waste handlers (86%) and doctors (83%) know about the tie-up than their counterpart. Further, three-fourth of the health-care staff knows the place where BMW treated, which is generated in their institute, here also, expectedly waste handlers (91%) fairly know than other health-care staff.

**Table 4.** Distribution of respondent's awareness about BMW and its management by designation ($n = 273$)

| Correct knowledge regarding bio-medical waste (yes %) | Health-care staff answering correctly: Doctors ($n = 29$) | Nurses ($n = 177$) | Pharmacist/ technicians ($n = 23$) | Waste handlers ($n = 44$) | Total ($n = 273$) | $p$-value |
|---|---|---|---|---|---|---|
| K1: all health-care waste is hazardous | 48.3 | 46.3 | 56.5 | 40.9 | 46.5 | 0.091 |
| K2: received training for BMWM | 31.0 | 49.2 | 43.5 | 43.2 | 45.8 | 0.193 |
| K3: know about existence of BMW rule | 86.2 | 81.4 | 78.3 | 20.5 | 71.8 | <0.001 |
| K4: know the years BMW rule enacted | 20.7 | 9.6 | 0.0 | 0.0 | 8.4 | 0.006 |
| K5: know agency implement BMW rule | 41.4 | 5.6 | 13.0 | 2.3 | 9.5 | <0.001 |
| K6: no. of colour bags/containers to be used | 72.4 | 81.4 | 65.2 | 70.5 | 77.3 | 0.007 |
| K7: know bio-hazard symbol | 72.4 | 71.2 | 60.9 | 50.0 | 67.0 | 0.011 |
| K8: maximum storage time of hazardous waste | 34.5 | 18.6 | 26.1 | 22.7 | 21.6 | 0.073 |
| K9: disease spread by improper BMWM | 100.0 | 99.4 | 100.0 | 95.5 | 98.9 | 0.308 |

**Note:** $\chi^2$ = Pearson chi-square test at 5% significance level

| Favorable attitude regarding bio-medical waste (yes %) | Health-care staff answering correctly | | | | | |
|---|---|---|---|---|---|---|
| | Doctors ($n$ = 29) | Nurses ($n$ = 177) | Pharmacists/ technicians ($n$ = 23) | Waste handlers ($n$ = 44) | Total ($n$ = 273) | $p$-value |
| A1: important to know the generation, hazards and legislation | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | $ |
| A2: safe management of BMW is an issue of concern | 96.6 | 100.0 | 100.0 | 97.7 | 99.3 | 0.119 |
| A3: necessary to segregate waste at the point of origin | 89.7 | 94.4 | 100.0 | 100.0 | 95.2 | 0.412 |
| A4: safe management increases the financial burden of the hospital | 34.5 | 11.9 | 8.7 | 9.1 | 13.6 | 0.001 |
| A5: BMWM is a part of our professional responsibility | 100.0 | 100.0 | 100.0 | 97.7 | 99.6 | 0.156 |
| A6: necessary to wear PPE | 96.6 | 96.6 | 100.0 | 100.0 | 97.4 | 0.857 |
| A7: BMWM is an extra burden of work | 24.1 | 8.5 | 4.3 | 15.9 | 11.0 | 0.038 |
| A8: knowledge regarding BMW is adequate | 65.5 | 81.4 | 87.0 | 81.8 | 80.2 | 0.047 |
| A9: require further training on BMWM | 86.2 | 91.5 | 87.0 | 86.4 | 89.7 | 0.368 |

**Notes:** $\chi^2$ = Pearson chi-square test at 5% significance level; $ = no statistics are computed because variable is a constant

**Table 5.** Distribution of respondent's attitude about BMW and its management by designation ($n$ = 273)

Approximately, 72% doctors, 64% nursing staff, 61% waste handlers and only 30% LTs/ pharmacists agreed that their institute maintain records regarding BMW. All, the health-care staff (99%) agrees that they follow colour-coding and segregation at workplace. Little more than two-thirds of the respondents disposed of non-infected waste (Cytotoxic drugs and chemical waste) in a black bag, 87% disposed soiled waste (non-plastic infected blood-soaked cotton, gauze, dressings, pop casts, etc.) into the red bag, 78% disposed of Anatomical waste (placenta, pathological waste and body parts) in the yellow bag, 87% disposed infected plastics (syringes, gloves and plastic waste) in a blue bag and 87% disposed sharps (needles and cut glasses) in White bag/container. Immunization for Hepatitis-B is very poor amongst waste handlers (43%). All variables, except the following segregation at the workplace, are statistically significant at a 5% significant level.

## Discussion

The basic and crucial requirement for the proper segregation and handling of BMW is adequate training (Ogbonna *et al.*, 2012; Hosny *et al.*, 2018); however, in this study, only 46% of the study participants were trained, which is better than finding from earlier studies from India (Ismail *et al.*, 2013) and even from Ethiopia (Deress *et al.*, 2019). However, a study in the Nigerian setting shows better findings (81%) of the same (Nwankwo, 2018).

Further, the health-care staff are involved in works, which generate BMW, and are also responsible for segregation, handling and management of the same. These staffs are required to be vaccinated for Tetanus and HBV (Chartier *et al.*, 2014). In this study, overall around 95% and 74% of the respondent were vaccinated for tetanus and HBV, respectively; whereas, results also show that only 43% of waste handlers were vaccinated for HBV. However, tetanus and HBV vaccination in the current study was far better than earlier studies in Ethiopian (Deress *et al.*, 2019) and Indian settings (Ismail *et al.*, 2013; Gupta *et al.*, 2016).

| Correct practice regarding bio-medical waste (yes %) | Health-care staff answering correctly | | | | | |
|---|---|---|---|---|---|---|
| | Doctors ($n = 29$) | Nurses ($n = 177$) | Pharmacist/ technicians ($n = 23$) | Waste handlers ($n = 44$) | Total ($n = 273$) | $p$-value |
| P1: institute tie-up with waste disposal agency | 82.8 | 66.7 | 65.2 | 86.4 | 71.4 | <0.001 |
| P2: know the place where BMW treated | 82.8 | 68.9 | 82.6 | 90.9 | 75.1 | 0.011 |
| P3: maintaining BMW records at work place | 72.4 | 63.8 | 30.4 | 61.4 | 61.5 | <0.001 |
| P4: follow segregation at work place | 96.6 | 100.0 | 100.0 | 97.7 | 99.3 | 0.119 |
| P5: practicing the correct method for collecting | | | | | | |
| Non-infected waste | 48.3 | 76.8 | 52.2 | 52.3 | 67.8 | 0.002 |
| Soiled waste | 48.3 | 94.9 | 73.9 | 88.6 | 87.2 | <0.001 |
| Anatomical waste | 58.6 | 86.4 | 34.8 | 81.8 | 78.4 | <0.001 |
| Infected plastics | 55.2 | 93.2 | 73.9 | 88.6 | 86.8 | <0.001 |
| Sharps | 65.5 | 92.1 | 73.9 | 97.7 | 88.6 | <0.001 |
| P6: vaccinated against tetanus | 93.1 | 97.2 | 82.6 | 90.9 | 94.5 | 0.019 |
| P7: vaccinated against hepatitis B | 96.6 | 77.4 | 73.9 | 43.2 | 73.6 | <0.001 |

**Note:** $\chi^2$ = Pearson chi-square test at 5% significance level

**Table 6.** Distribution of respondent's practise about BMW and its management by designation ($n = 273$)

Furthermore, the usage of PPEs amongst health-care staff, especially waste handlers, was very poor in the present study (results not shown in table).

In the current study, only 43% of the respondents were aware of the correct categorization and segregation in colour-coding bins of all categories of BMW, however, by separate categories the awareness is comparatively fair. Moreover, 63%, 80% and 72% of the study participants identified that general, infectious and sharp wastes should be disposed of in a black, yellow and a safe box, respectively. More or less the same results were obtained in a research study in Ethiopia (Deress *et al.*, 2019).

## Conclusion and recommendations

Awareness of correct categorization of BMW and its proper colour-coding disposal was poor amongst all categories of public health-care personnel. Although, doctors were observed to be good in theoretical knowledge such as rules, legislation and public health importance of proper waste management than in the more practical aspects of BMW management. While in case of nurses, LTs/pharmacists and waste handlers the reverse was true, i.e. though their theoretical knowledge lagged behind that of doctors, their practical knowledge regarding waste segregation in colour bins and disposal methods was better.

All categories of health-care staff have got positive attitude towards BMWM, but this is not converting into a good practise. It may be due to lack of knowledge, lack of resources and supportive environment to practise.

The need for comprehensive training programs about BMW management including-segregation, in-house transportation, storage of waste in colour bins and final disposal for treatment, etc., for all hospital staff is highly recommended. Biomedical waste (management and handling) rules should be implemented strictly. Establish proper supervision on following protocols, guidelines regarding BMWM in each facility. Steps should be taken for supply of utility PPEs and its proper use by sanitary staff. Ensure the availability of necessary resources i.e. trolley, colour-coded bins and bags, display of charts, etc. Further, proper system for the

indenting and procurement of necessary materials for BMWM should be established. Ensure the timely removal of BMW from facility by CTF agency. All, the health-care personnel should be vaccinated against Tetanus and Hepatitis-B, especially waste handlers and sanitary workers.

## Limitations of the study

The study was conducted in health facilities from three district of north Karnataka, the districts were selected purposively due to time and fund constraints. Hence, the results may not represent other health facilities and health-care staffs elsewhere in different regions and locations of the country.

## Notes

1. Karnataka is a state in the south western region of India. It was formed on 1 November 1956, with the passage of the States Reorganisation Act. Originally known as the State of Mysore, it was renamed Karnataka in 1973.
2. Districts are local administrative units; they generally form the tier of local government immediately below that of India's sub-national states and territories.
3. Tehsil, which is also called as Taluka or Block, is an administrative sub-district division, typically comprising a number of villages.
4. Availability of proper training and guidelines, BMWM team/ manpower/ staff and proper co-ordination between different stakeholders
5. Financial aid, BMW equipment and incinerator, indenting and procuring of material, providing logistics, segregation resources and facilities for in-house transportation and storage, etc.
6. Monthly meeting, Segregation processes and Disposal system to be put in place, etc.
7. Improved administration, Separate department for BMWM, penalty on implementing agencies, strict rules implemented and maintain supervision, etc.

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