

Awareness and Practice of Biomedical Waste Management in Indian Setting (2012-2016): Systematic Review

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Review Article

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ABSTRACT

Biomedical waste management rule (2016) redefines the classification of biomedical waste as per colour coded containers for improving the segregation of biomedical waste. The present review analyses the awareness and practice of biomedical waste management by various health care professionals in Indian setting. We included studies that assessed the awareness and practice of segregation and treatment procedures regarding biomedical waste management conducted at Indian setting published in the period from 2012-2016 in the electronic databases: Medline, EMBASE & Google scholar using STROBE checklist. 19 studies of awareness and 9 studies of practice regarding biomedical waste management were finally met the review's inclusion criteria. Results of the 19 studies conducted among various health professionals revealed that half of the participants (50%) were aware about correct colour coding of bags for segregation of biomedical waste. Segregation of biomedical waste was adequate in most of the studies conducted at tertiary care settings (60-80%), while it was poor at small health care facilities. More than half of the settings in the included studies were not equipped with a common bio-medical waste management treatment facility. The present review suggests the need of training and evaluation of biomedical waste management practices with homogenous research instruments among various health professionals in Indian setting.

BACKGROUND

Biomedical wastes are the waste generated from medical procedures within healthcare facilities. It includes human and animal anatomical waste and treatment apparatus that are used and generated during diagnosis, treatment or immunization in hospitals, nursing homes, pathological laboratories (WHO, 2013) ^[1]. The scientific disposal of biomedical waste through segregation, collection and treatment is called as biomedical waste management. The proper management of biomedical waste decreases the spread of infection by preventing the mixing of hazardous and non-hazardous biomedical waste ^[2].

Government of India has drafted rules and regulations related to biomedical waste management since 1998 and its recent amendments has undergone on 2016 ^[3-5]. One of the major changes in the 2016 BMW rule is the classification of biomedical wastes into 4 categories as compared to 10 categories of biomedical waste listed in the previous rule (BMW rule, 2011) ^[4]. The classification of biomedical waste as per colour coded containers is majorly revised for improving the segregation of biomedical waste ^[5]. The present review analyses the awareness and practice of biomedical waste management by health care professionals in Indian setting.

METHODS

We included studies that assessed the awareness regarding biomedical waste management among different health care professionals employed at various health care settings of India. Biomedical waste management practice was evaluated by including studies which reported practice of segregation, treatment and disposal procedures in patient care areas.

LITERATURE SEARCH

Relevant studies published in the period from 2012-2016 were identified by using electronic databases: Medline, EMBASE & Google scholar. Search strategy used the following key words: ‘awareness’, ‘biomedical waste management’, ‘practice’, ‘India’. An extensive evaluation of the relevant articles was carried out using STROBE checklist for observational studies [6]. There was a variation in research instruments, outcome measures, estimation of sample size in the potentially relevant studies. We analysed the included studies based on certain characteristics of such as study setting, participants, segregation, treatment procedures and major findings. Principal author searched and selected the potentially relevant studies. Data extraction and final selection of the characteristics of each study were done by a further peer review process.

RESULTS

We identified 568 potentially relevant references in which 98 were retrieved for further evaluation. Studies regarding awareness of biomedical waste management conducted at teaching institutions were excluded in this review. **Figure 1** provides the sequence of the inclusion process of references in the systematic review. Descriptions of the characteristics of the included trials regarding awareness and practice of biomedical waste management are summarized in **Tables 1 and 2**.

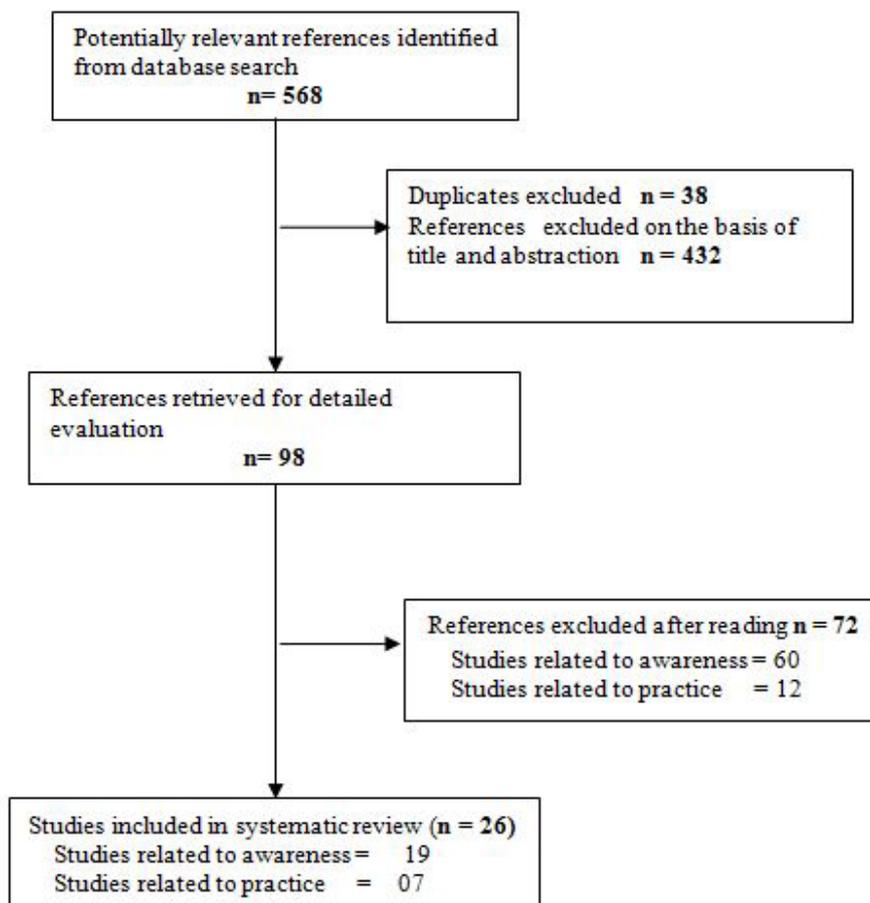


Figure 1. Flow chart of the inclusion process of references in the systematic review.

Table 1. Awareness regarding biomedical waste management in Indian setting.

Authors	Participants (n)	Setting/State	Awareness
Vishal et al. [7]	Doctors (38) Nurses (44) Lab technicians (21) Others (7)	Tertiary care hospital/ Madhya Pradesh	Overall 50% of the participants were aware about segregation of waste in colour containers. Knowledge related to segregation, colour coding, storage and disposal of biomedical wastes were higher among nurses (70-77%) than other health care professionals.
Basu et al. [8]	Medical interns (200)	Tertiary care hospital/ West Bengal	77.4% of participants were aware about color-coded bags for bio medical wastes and only 29.5% of had the knowledge related to final disposal of bio medical wastes.

Srivastava et al. ^[9]	Nurses (39) Pharmacist (18) Lab technicians (12) Other (3)	District Hospital/Uttar Pradesh	Majority of the population were unaware about the segregation, colour coded bags and hazards related to biomedical waste management (75%).
Bansal et al. ^[10]	Dental practitioners (100)	Dental clinics/ Chandigarh	Around 12% of the population were not aware of different categories and colour coding related to biomedical waste management.
Asadullah et al. ^[11]	Nurses (166)	Private Hospitals/ Karnataka	Half of the participants were having complete awareness (100% knowledge as per research tool) on colour coding, categories and disposal related to biomedical waste management.
Acharya et al. ^[12]	Medical interns (106)	Tertiary care hospital/ New Delhi	Awareness of biomedical waste management related to injection and safe disposal were poor among most of the participants (27%).
Kishore et al. ^[13]	Health care workers (116)	Private nursing homes/ New Delhi	Around half of the participants were not aware about the colour coded bags and disposal related to biomedical waste management (47%).
Singh et al. ^[14]	Dental practitioners (160)	Dental clinics/Uttar Pradesh	Majority of the participants were unaware about the different categories related to biomedical waste management (67%).
Balamurugan et al. ^[15]	Nurse (67) Lab technician (65) Sanitary staff (68)	Tertiary care hospital/ Tamil Nadu	Overall 33% of the participants were aware about segregation of waste in colour containers. 30-40% of nurses and lab technicians were having adequate knowledge on the categories, colour coding and disposal related biomedical waste management. However around 75% of the sanitary attendants were unaware about the same.
Bhagawati et al. ^[16]	Doctors (26) Nurses (29) Lab technicians (20) Other (35)	Tertiary care hospital/ New Delhi	Overall only 17% of the population were aware of the number of categories related to biomedical waste management. Awareness related to guidelines of BMW was least among the doctors (73%) as compared to the nurses (96.55%), technicians (90%) and other paramedical staff (88.57%).
Kumar et al. ^[17]	Doctor (51) Nurse (103) Lab technician (42) Sanitary staff (24)	Tertiary care hospital/ Uttarakhand	Awareness regarding the disposal of biomedical wastes as per colour coded bags was found to be poor among different categories of health care workers (less than 60%, 60%, 45%, 37% and 27% for nurses, doctors, sanitary staffs and lab technicians, respectively).
Sehgal et al. ^[18]	Doctor (30) Nurse (30) Lab technician (30) Sanitary staff (30)	Tertiary care hospital/ New Delhi	Awareness regarding the guidelines and colour coding related to biomedical waste management were found to be satisfactory among the study population (more than 84%). Knowledge about correct colour coding for biomedical waste disposal was least among doctors (76%) and maximum among laboratory technicians (100%).
Indupalli et al. ^[19]	Nurses (100)	Tertiary care hospital/ Karnataka	Knowledge related to the correct categories of biomedical waste as per specific colour coded containers was found to be poor among respondents (30%).
Kaur et al. ^[20]	Doctor (41) Interns (18) Nurse (23) Lab technician (18) Other (25)	Tertiary care hospital/ Maharashtra	Over all 64% of the total subjects were about segregation and colour code of biomedical wastes in which highest knowledge was among nurses (87%) and least among sanitary staffs (36%).
Anand et al. ^[21]	Doctor (120) Nurses (110) Lab technicians (15) Class IV workers (60)	Tertiary care hospital/ Haryana	Over all 73% of the total subjects was segregation of biomedical waste as per colour coded containers. Knowledge related to the categories, colour coding and disposal related to biomedical waste management were 70-90% among doctors, nurses and lab technicians and poor among class C employees (25-30%).
Das et al. ^[22]	Doctor (56) Nurse (58) Lab technician (13) Other (71)	Tertiary care hospital/ West Bengal	Knowledge on correct categories, colour coding and disposal related to biomedical waste management found to be less than 30% among the participants.
Ananthachari et al. ^[23]	Doctor (147) Interns (127) Nurse (209) Lab technician (84)	Tertiary care hospital/ Kerala	Around 64% of the population were aware of proper colour coding related to biomedical waste management and knowledge was maximum among nurses and least among lab technicians.
Sarotra et al. ^[24]	Nurse (47) Hospital Attendants (76) Sanitary Attendants (48)	Tertiary care hospital/ Chandigarh	Knowledge related to the proper colour coding, segregation and disposal were poor among sanitary attendants (23%) as compared to hospital attendants and nurses (70%).
Pullishery et al. ^[25]	Doctor Nurse Lab technician Sanitary staff (157)	Public & private health care facilities/ Karnataka	Over all 43% of the total subjects were aware about correct colour coded bags for waste disposal. Knowledge about colour coding and waste segregation of biomedical waste was higher among nurses (73%) and poor among sanitary attendants (10%).

Table 2. Status of biomedical waste management in Indian setting.

Authors	Setting	No of health facilities/beds	Segregation	Treatment & final disposal	Quantity of waste (Kg /day)	Major findings
INCLIN Study [26]	20 states of India	Public sector (n=238) Private sector (n=199)	Better at public sector in urban areas & Poor at private sector in rural area	Not adequately reported	6.13 (Primary care) 16.4 (Secondary care) 62.7 (Tertiary care)	Around 82% of primary, 60% of secondary and 54% of tertiary care health facilities are not equipped with a credible biomedical waste management system.
Manar et al. [27]	Uttar Pradesh/ Private sector	8/1008 beds	Inadequate	Hospitals with bed strength ranging 12-100 were not equipped with treatment facilities as per standards	0.5/bed	The availability of resources and treatment facilities related to biomedical waste management is poor in hospitals with bed strength ranging from 12 to 100.
Singh et al. [28]	Uttar Pradesh/ Government sector	325 beds	Adequate	Adequate	0.11/bed	Status of biomedical waste management system is adequate in this setting as per the standards. All the infectious waste is sending to a common Bio-medical Waste Management Treatment Facility (CBWTF) for treatment and final disposal.
Kumar et al. [29]	Chandigarh/ Government sector	1100 beds	Adequate (96%)	Mutilation of recyclable waste was 80% and disinfection of waste was 60% in treatment room of wards.	Not reported	The treatment of biomedical waste in terms of mutilation of recyclable waste and disinfection of waste in treatment room of wards need to be improved in this setting.
Sengodan [30]	Tamil Nadu/ Government sector	1020 beds	Adequate	Not reported	0.06/bed	There is a reduction in the biomedical waste generated per bed per day retrospectively for past 3 years in this setting.
Patan et al. [31]	Rajasthan/ Government sector	200 beds	Inadequate	Inadequate	0.15/bed	There is a lacuna in policy and proper management of biomedical waste (segregation, transport, storage and treatment disposal) in this setting.
Chetana et al. [32]	Karnataka/ Private sector	35 nursing homes (<50 beds)	Segregation at the point of generation was present in 62.9% of the setting	80% of the setting have Common Bio-medical Waste Treatment Facility	Not reported	Although segregation of biomedical waste was carried out around 63% of the settings, only 16 % of the setting was maintaining segregation process as per standards. Deficiencies were observed in areas of containment, sharps management and disinfection.
Gadicherla et al. [33]	Karnataka/ Public and Private sector	115 Health care facilities (9 large-Above 500 beds, 17 medium-100-500 beds and 90 small-Below 100 beds health care facilities)	Segregation of biomedical waste in medium and large HCFs was average to excellent, while it was poor in 24.4% of small HCFs	Around 88% of large and medium health care facilities and 47% of small health care facilities have Common Bio-medical Waste Treatment Facility	Not reported	There is a lacuna in the segregation and management of biomedical waste at all health care facilities especially at small health care facilities (<100 beds) in this setting.
Pandey et al. [34]	Uttar Pradesh/ Private sector	1100 beds	30-35% health care professionals were not following the proper segregation practices	There is a Common Bio-medical Waste Treatment Facility	0.34/bed	The practice of segregation of biomedical waste was poor with mixing of infectious waste with non-infectious waste in this setting.

AWARENESS OF BIOMEDICAL WASTE MANAGEMENT

The present review identified 19 cross sectional studies in which awareness of biomedical waste management was evaluated among different health care professionals such as doctors, nurses, pharmacist, lab attendants, hospital and sanitary attendants dental practitioners and medical interns [7-25]. The total number of participants were 3303 in which major proportion of the subjects were nurses (n=1192), doctors (n=709) and dentists (n=510), respectively.

More than half of the studies (n=13) were conducted at tertiary health care settings of the following states of India: New Delhi (n=3), West Bengal (n=2), Uttarakhand (n=1), Chandigarh (n=1), Haryana (n=1), Madhya Pradesh (n=1), Maharashtra (n=1), Tamil Nadu (n=1), Karnataka (n=1) and Kerala (n=1). Of the 13 studies conducted at tertiary health care settings, 17-37% (n=6 studies) and 50-80% (n=7 studies) of the total study subjects were aware about colour coded containers regarding biomedical waste management. Most of the studies conducted at tertiary health care settings (n=8) revealed that knowledge related to correct colour coding, segregation and disposal methods related to biomedical waste management were highest among nurses and poor among sanitary staffs [7,15-17,20,21,23,24]. Studies conducted among medical interns found that around 70-80% of the participants were unaware about safe disposal methods related to biomedical waste management [8,12].

One study conducted at district hospital settings of Uttar Pradesh found that majority of the participants were unaware about the segregation, colour coded bags and hazards related to biomedical waste management (75%) [9]. Three studies conducted at public and private health care settings found that around half of the participants were unaware about correct colour coded bags for waste disposal [11,13,25]. Two studies conducted among dental practitioners found that around 12-67% of the participants were unaware of different colour coded bags related to biomedical waste management [4,8].

PRACTICE OF BIOMEDICAL WASTE MANAGEMENT

The present review identified 9 studies that evaluated biomedical waste management at Indian setting [26-34]. With the exception of one study conducted at a secondary health care facility [28], all the other included studies (n=8) reported a poor practice of biomedical waste management at various levels of health care facilities. One large study analysed the practice of biomedical waste management across 20 states of India and found that segregation of biomedical waste was better at public sector in urban areas & poor at private sector in rural area. The study also pointed out that around 82% of primary, 60% of secondary and 54% of tertiary care health facilities were not equipped with a credible biomedical waste management system [26]. Segregation of biomedical waste was found to be adequate in two studies conducted at tertiary care hospitals in the government sector with bed strength up to 1100 [29,30]. However studies conducted at small health care facilities with bed strength up to 100 found deficiencies in maintain standards regarding segregation of biomedical waste [27,33,34]. Four studies conducted at various levels of health care facilities reported the practice of sending biomedical waste to a common Bio-medical Waste Management Treatment Facility (CBWTF) [28,32-34]. A study conducted at a government owned tertiary care hospital found a lacuna in the mutilation of recyclable waste and disinfection of waste in treatment room of wards [29].

DISCUSSION

The present article is an exploration of the awareness and practice of biomedical waste management as per Indian scenario. There is a significant variation in the awareness and practice of biomedical waste management as per different health professionals and settings. This is mainly due to the variation in tools of data collection as most of the studies used different self-reported questionnaire for gathering the information. Hence the findings of the studies are summarized based on the common facts regarding biomedical waste management as per the research tools.

Results of the 15 studies conducted among doctors, nurses, lab technicians, pharmacist and sanitary staffs revealed that half of the participants (50%) were aware about correct colour coding of bags for segregation of biomedical waste. Studies conducted among dental practitioners (n=2) and medical interns (n=2) found a huge variation in knowledge regarding biomedical waste management ranging from 12 to 75%. Biomedical waste management rule (2016) [5] provide more emphasis on the safe management of biomedical wastes without causing any deleterious impact on human health and environment. The bar coding of the containers containing biomedical waste are recommended as it may help in improving the segregation, transportation and disposal system. The biomedical wastes to be included in the four colour coded bags are as follows. Yellow bag waste includes (a) human and animal anatomical waste such as body tissues, organs (b) soiled waste such as dressing, cotton swabs, discarded bags containing blood products, plaster casts (c) expired or discarded medications such as antibiotics, cytotoxic drugs (d) chemical waste including chemical liquid waste such as discarded formalin, aspirated body fluids, disinfectants (d) clinical laboratory wastes such as laboratory cultures and discarded linen, mattress and beddings contaminated with blood or body fluids. Red bag waste includes all the recyclable contaminated biomedical waste such as tubing, bottles, IV sets, catheters, urinary bags and syringes without needles. Blue bag waste includes all the broken or discarded glassware such as medicine vials, ampoules

except those contaminated with cytotoxic wastes and metallic body implants. White bag waste includes all the waste sharps including metals such as used or discarded needles, scalpels, blades. The present review identified that there is a lacuna in knowledge regarding the correct use of colour coded containers regarding biomedical waste across various health professionals at various health setting.

Biomedical waste management rule (2016) redefines that the health care facility should make a common bio-medical waste treatment facility within the premises (within 75 km) of the health care facility for the safe segregation and storage of biomedical waste in order to prevent possible mishandling^[5]. Segregation of biomedical waste was adequate in two studies conducted at tertiary care settings^[29,30], while it was poor at small health care facilities.^[27,33,34] Despite adequate awareness regarding biomedical waste management, two studies reported the poor practice of segregation procedures as per standards^[32,34]. The revised rule focus (BMW rule, 2016) more on the pre-treatment of biomedical waste before its final disposal as per WHO or NACO guidelines in order to avoid possible microbial contamination^[5]. Four studies in the present review reported the practice of sending bio medical waste to a Common Bio-medical Waste Management Treatment Facility (CBWTF) for treatment and final disposal^[28,32-34].

The systematic review has the following limitations. The findings of the study were based on heterogeneous self-reported research questionnaires at various health care facilities among different health care professionals. Although there are studies related to the awareness regarding biomedical waste management, the studies on practice of biomedical waste management in Indian setting is limited. However the present review provides a systematic narration of the research on awareness and practice regarding biomedical waste management in Indian setting.

CONCLUSION

Based on the research studies conducted at various health care settings revealed that there is a significant variation in knowledge regarding biomedical waste management among various health professionals employed at different health care settings of India. The practice of biomedical waste management is need to be improved at all health care facilities especially at small health care facilities. The present review suggests the need of training and evaluation of biomedical waste management practices with homogenous research instruments among various health professionals in Indian setting.

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