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Original Research Article

Compliance with standard norms in collection, segregation and transport of biomedical waste in a tertiary care hospital: a cross-sectional study

Aniruddha A. Malgaonkar*, S. Kartikeyan

Department of Community Medicine, Rajiv Gandhi Medical College, Kalwa, Thane - 400605, Maharashtra, India

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***Correspondence:**
Dr. Aniruddha A. Malgaonkar,
E-mail: andydr@rediffmail.com

ABSTRACT

Background: This cross-sectional study was conducted to determine the gaps between the stipulated procedures for collection, segregation and transportation of bio-medical waste (BMW) and the actual practices; the levels of BMW-related awareness and training status of hospital employees; the protocols for occupational exposure to hazardous BMW and their implementation; and to recommend corrective measures.
Methods: Primary data were collected by interviewing the staff in-charge of all BMW generating units of a tertiary care hospital and by recording information by direct on-site observation on a checklist. The participant's confidentiality was maintained throughout the study.
Results: The interviews and actual observations in 26 BMW generating units (out-patient departments, in-patient wards, laboratories, operation theatres, post-mortem room) revealed availability of trained person in-charge for BMW (3.85%), mixing of infectious and non-infectious waste at point of generation (73.07%), untreated syringes sent for final disposal (60.86%), availability of colour-coded bags (50%) and absence of puncture-proof containers (85.71%). 84.61% of interviewees reported having taken tetanus and hepatitis B immunizations.
Conclusions: The necessary interventions include periodic training and re-training of personnel, active supervision of BMW handlers to enforce the use of protective gear and vaccination of all staff against tetanus and hepatitis B. Periodic BMW audit would be essential to determine the trends in the diversity and quantities of waste produced in health care settings and facilitate administrators to devise strategies for improved management of BMW.

Keywords: Bio-medical waste, Hospital personnel, Medical waste disposal

INTRODUCTION

"Bio-medical waste" (BMW) has been defined as "any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or research activities pertaining thereto or in the production or testing of biologicals or in health camps."[1] The Government of India has stipulated procedures for collection, segregation, transportation and disposal of BMW.[2] BMW must be properly managed and disposed off, to protect the environment and general public. The average rate of generation of BMW in hospitals and medical laboratories have been estimated by various researchers.[3-6] Copious amounts of BMW, if not managed appropriately, can spread highly contagious diseases either by contact transmission or by contamination of air, water and soil.

Healthcare and sanitation workers are occupationally at risk of exposure to biomedical waste. The hazardous chemical waste produced in health care settings can cause extensive harm to the ecosystem and the environment.[7] This study was conducted in a tertiary care hospital to

ascertain the compliance of collection, segregation, transportation of BMW with stipulated norms; to determine the levels of personnel training, protective measures and practices in the event of exposure to BMW.

METHODS

This cross-sectional study was conducted in all the out-patient departments, in-patient wards, laboratories, operation theatres, post-mortem room, and other BMW generating sites of a tertiary care hospital in Western India.

After obtaining approval from the Institutional Ethics Committee, the staff in-charge of all the BMW generating units were explained about the purpose of the study and written informed consent was obtained. The participant's confidentiality was maintained throughout the study.

Primary data were collected in a dual mode by both researchers (AAM and SK). The first mode of data collection was to interview the staff in-charge of BMW management in each unit of the hospital at a time convenient to them using a semi-structured pre-tested questionnaire (eight parameters). Some of the questions pertaining to disposal of BMW were adapted from a checklist.[8] The second mode of data collection comprised on-site observations by the same researchers. The Observation Checklist comprised nine parameters - equipment and trained manpower availability, collection, segregation and storage of biomedical waste, management of different streams and spills, personal protection, transport and prior treatment of biomedical waste.

The interview responses and confirmation (or otherwise) by observations were tabulated and statistically analysed using EpiInfo Version 7.0 (public domain software package from Centre for Disease Control and Prevention, Atlanta, GA, USA). Statistical significance of difference (taken as p-value<0.05) was calculated using Karl Pearson's Chi-square test (with Mantel-Haenszel correction where applicable).

RESULTS

Of the 26 units surveyed, there were eleven wards, four emergency wards, two laboratories, two out-patient departments, three operation theatres and two procedure rooms. The results were classified under the following headings:

Equipment availability

Interview responses, confirmed by observation revealed that 15.38% units did not have adequate number of bins (four bins per unit). Availability of adequate numbers of colour-coded bags inside the bins and puncture-proof containers for disposal of sharps was found to be less than that claimed during interview (Table 1). Interview responses, validated by observation revealed that needle and syringe cutters were not present in 2 out of 25 units. (Table 1).

Table 1: Equipment availability (n = 26).

		Yes	Percent	Chi^2 value #	p-value
Adequate bins available	Interview	22 / 26	84.62	0.1477	0.7
	Observation	22 / 26	84.62		
Adequate bags available	Interview	17 / 26	65.38	1.26	0.261
	Observation	13 / 26	50.00		
Puncture-proof containers for sharps	Interview	10 / 24	41.67	3.79	0.05
	Observation	03 / 24	12.50		
Needle cutter available	Interview	23 / 25	92.00	0.271	0.602
	Observation	23 / 25	92.00		
BMW Record Register available	Interview	23 / 26	88.46	11.94	0.0005*
	Observation	10 / 26	38.46		
Blood spill management kits	Interview	02 / 26	07.69	0	1
	Observation	01 / 26	03.85		
Separate lockers for BMW equipment	Interview	10 / 26	38.46	7.38	0.006*
	Observation	01 / 26	03.85		
Reporting formats for BMW	Interview	01 / 26	03.85	0.271	0.602
	Observation	03 / 26	11.54		

*Statistically significant; # Chi-square test with Mantel-Haenszel correction where applicable.

All units had adequate availability of personal protective gear (gloves, caps, masks and aprons) and 1% fresh hypochlorite solution (or powder) as per interview responses, which were authenticated by observations.

Absence of gumboots, mentioned during interview by all units, was validated by observation. The differences between interview responses and observations regarding presence of BMW Management Register was statistically significant (p=0.0005). Interview responses and observation confirmed that mercury spill management kits did not exist in any unit. The differences between interview responses and observations regarding presence of Blood Spill Management Kits were not significant; but that regarding separate lockers for keeping BMW equipment were significant (p=0.006).

Table 2: Disposal of BMW at generation site.

		Yes	Percent	Chi^2 value #	p-value
Disposal of sharps in puncture-proof containers	Interview	01 / 26	03.85	0	1
	Observation	0 / 26	0.00		
Disposal of sharps in plastic jerry cans	Interview	12 / 26	46.15	0.693	0.405
	Observation	15 / 26	57.69		
Disposal of sharps in other containers	Interview	13 / 26	50.00	0.31	0.578
	Observation	11 / 26	42.31		
Disposal of NSIW in bins with yellow bags	Interview	18 / 23	72.00	9.68	0.002*
	Observation	07 / 23	28.00		

NSIW = Non-sharp infectious waste; * Statistically significant; # Chi-square test with *Mantel-Haenszel* correction where applicable

Table 3: Collection and storage.

		Yes	Percent	Chi2 value #	p-value
BMW collection in covered bins	Interview	02 / 26	07.69	0	1
	Observation	01 / 26	03.85		
Bins filled more than 3/4 capacity	Interview	12 / 26	46.15	0	1
	Observation	06 / 26	23.08		
Cleaning of bins ##	Interview	17 / 26	65.38	0	1
	Observation	25 / 26	96.15		

Chi-square test with Mantel-Haenszel correction where applicable; ## 4-12 hourly cleaning with soap and disinfectant.

Table 4: Pre-transport treatment.

		Yes	Percent	Chi^2 value #	p-value
Syringe disinfection with 1% hypochlorite	Interview	09 / 23	39.13	0	1
	Observation	09 / 23	39.13		
Infectious waste sent for disposal before chemical disinfection	Interview	09 / 26	34.62	0.719	0.397
	Observation	12 / 26	46.15		
Sputum cup disinfection with 1% hypochlorite	Interview	02 / 21	07.69	0	1
	Observation	02 / 21	07.69		
Blood Bag treatment with 1% hypochlorite	Interview	03 / 16	23.08	3.31	0.069
	Observation	0 / 16	0.00		

Chi-square test with Mantel-Haenszel correction where applicable

Trained manpower availability

Observation substantiated the interview response that in only one unit out of 26 (3.85%), BMW was managed by a trained person.

Waste segregation

There was discrepancy in interview responses and actual observations regarding the containers used for disposal of sharps (Table 2). In 86.95% (20 out of 23) units, broken glass and other sharps were disposed off as per protocol but only 73.91% (17 out of 23) units claimed to be doing so during the interview. Vials and ampoules were disposed off in sharp containers in three out of 25 units as per interview and on actual observation. Adherence to protocol, claimed in interview responses, were confirmed regarding segregation of non-sharp biomedical waste at the site of generation, segregation of anatomical waste, segregation of non-infectious waste. Infectious and non-infectious waste was found to be stored in the same bin in 19 out of 26 units.

Collection and storage

There was divergence in interview responses and actual observations regarding collection of BMW in covered bins and filling of bins to more than 75% of their capacity (Table 3).

Pre-transport treatment

14 out of 23 units sent untreated syringes for final disposal as per interview, which was confirmed by actual observation (Table 4). Though 9 out of 26 units responded that untreated infectious waste was sent for final disposal, it was observed that 14 out of 26 units did so. Observations revealed that blood bags were not disinfected in 5% sodium hypochlorite as per protocol in all the 16 units (where blood was transfused) but were returned to the blood bank, which also did not pre-treat the blood bags before final disposal. Blood bags were disposed off without mutilation by all the 16 units and the blood bank itself. All the 23 units (100%) that handled plastic waste (intravenous sets, syringes, catheters and latex gloves) sent the same for final disposal without pre-treatment as per interview, which was confirmed by actual observation.

Management of spills

As per interview, 8 out of 26 units disinfected spill (blood and body fluids) with 1% hypochlorite before cleaning but this was observed only in 6 out of 26 units. 24 out of 26 units admitted to reusing the cloth used for cleaning the spill. As per interview responses, none of the units collected spilt mercury as per protocol; the spilt mercury was disposed in drains and bins in all the 26 units.

Table 5: Personal protection.

		Yes	Percent	Chi^2 value #	p-value
Use of gloves and masks	Interview	25 / 26	96.15	0	1
	Observation	25 / 26	96.15		
Reuse of disposable gloves	Interview	0 / 26	0.00	0.52	0.47
	Observation	02 / 26	07.69		
Disposal of ampoules in sharp containers	Interview	03 / 25	12.00	0.148	0.7
	Observation	05 / 25	20.00		

Chi-square test with Mantel-Haenszel correction where applicable

Transport

BMW was transported in closed containers as per interview responses as well as from actual onsite observation in 13 out of 26 units (50%). A separate trolley with a pre-defined route for transporting BMW existed in all 26 units. The difference in interview responses and actual observation regarding BMW transport in open containers was significant (p=0.038).

Personal protection

Staff in 22 out of 26 units were immunised against tetanus and hepatitis-B, as per responses to interview. Personal protective equipment, such as, gloves and masks were used before procedures in all except one unit on interview and on actual observation. (Table-5) Despite claims to the contrary during interview, gloves and masks were found to be reused in 2 out of 26 units. Based on interview and observation, the practice of recapping or bending the needle was not found in any of the 25 needle-using units and sharps were not disposed off in open areas in all 26 units.

Pre-procedure hand washing was confirmed to be the norm in all the 26 units. It was revealed during interview by 80.76% (21 out of 26) units that a protocol was established in the event of an accidental exposure to BMW. However, this protocol was implemented only in 79.16% (19 out of 24) units where accidental exposures had occurred.

DISCUSSION

The present study revealed gaps in availability of some BMW-related equipment, availability of trained personnel for BMW management and awareness of BMW protocol. Contrasting results were obtained by a Bijapur-based study, which reported adequate levels of awareness and implementation of BMW management as per stipulated norms.[9] In a Kolkata-based study on junior doctors (who had been previously trained in BMW as part of their MBBS curriculum) revealed nebulous awareness of BMW, biohazard symbol, categories of BMW, waste segregation at source, colour-coding of bags and various methods of final disposal of BMW.[10] A study from Dhaka, Bangladesh reported that cleaners collected used needles and other sharps for reuse afterwards.[11]

Lack of effective BMW segregation, collection, transport, and disposal system has been reported in a 30-hospital

study in Sabarkantha district, Gujarat.[12] An Egypt-based study revealed that non-availability of written protocols was the cause of inadequate BMW management.[13] However, written protocols are available in the Indian situation and training and implementation of the protocol needs to be ensured.

The practice of recapping or bending needles was not observed in any of the needle-using units in the present study. However, a hospital-based cross-sectional study conducted in a tertiary private hospital in Bangalore revealed prevalence of faulty practices, such as, recapping of needles, among a majority of nurses and technicians.[14]

In this study, 84.61% of interviewed personnel were fully immunised against tetanus and hepatitis-B. However, only 38% nurses and 29% technicians in a tertiary care hospital in Bangalore had received hepatitis B vaccine, while a Kuwait-based retrospective study found that only 52.2% of the exposed health care personnel were fully vaccinated against hepatitis B.[14,15]

CONCLUSION

The necessary interventions include active supervision (including closed circuit television monitoring), enforcement of use of protective gear by BMW handlers, vaccination of all health care personnel against tetanus and hepatitis B. Periodic training of personnel is necessary to increase the awareness and practices related to BMW management, post-exposure prophylaxis and management of spills. Periodic BMW audit would be essential to determine the trends in the diversity and quantities of waste produced in health care settings and facilitate administrators to devise strategies for improved management of BMW.

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