Utility of the Biomedical Waste (BMW) Mobile App for Auditing BMW Segregation Practices in a Surgical Discipline of a Tertiary Care Hospital

Kuyare Sunil[1], Ginodia Saumitra[2], Warke Himangi[3], Kasar Smita[4], Bhosle Vaibhav[5], Nataraj Gita[6]

[1]Former Associate Professor, Dept. of Microbiology, Seth GS Medical College and KEM Hospital, Mumbai
[2]Medical Student, Seth GS Medical College and KEM Hospital, Mumbai
[3]Associate Professor, Dept. of Obstetrics and Gynaecology, Seth GS Medical College and KEM Hospital, Mumbai
[4]Associate Professor and Head, CSE department, MIT, Aurangabad, Maharashtra
[5]Ex- Student, MIT, Aurangabad, Maharashtra
[6]Former Professor and Head, Dept. of Microbiology, Seth GS Medical College and KEM Hospital, Mumbai

Abstract

Background: Appropriate segregation of biomedical waste is necessary not only legally but also for safer environment and health care worker protection. Presently, BMW Management Rules 2016 has been notified in India. Inappropriate waste segregation is the biggest challenge. Audits are known to help identify lacunae and improve practices. However, conventional audits require paper documentation and communication to different departments and are time consuming which makes it difficult to implement/sustain. The present study was planned to assess the utility of newly conceptualized(copyrighted) mobile app as an audit tool to improve waste segregation practices.

Methodology: The mobile app captures practices while maintaining strict confidentiality and works on android based application ensuring restricted and password protected access.

After approval from Institutional Ethics Committee, a prospective study was planned in a surgical discipline using the mobile app which included observation of the waste segregation practices in two phases i.e. pre intervention and post intervention for a period of one month each(intervention being training on appropriate waste segregation practices). Waste segregation practices were analyzed.

Results: During pre-training audit, 93.4%(1032/1105 observations) of biomedical waste segregation practices were found to be appropriate. Inappropriate segregation was found with reference to waste in yellow category(63%) followed by red category(17.8%). The items that were inappropriately segregated included gloves(52.5%), plastic apron(7.5%), blood bags(7.5%) and non-infectious waste(8.8%). Post training, appropriate segregation improved to 99.7%(1490/1495 observations) which was statistically significant($p<0.05$).

Conclusion: Mobile app was found to be useful in reducing inappropriate segregation practices. It is easy to use and will support implementation process.

Introduction

The term "biomedical waste" has been defined as "any waste that is generated during diagnosis, treatment or immunization of human beings or animals, or research activities pertaining thereto or in the production or testing of biologicals or in health camps.[1] There are two major hazards arising from inappropriate waste disposal practices. First is the hazard of potentially infectious material that the individuals handling waste will be exposed to, most notably being needle stick injury [2] and second is the environmental burden of a variety of hazardous products. The severity of the threat is further compounded by the high prevalence of diseases such as human immunodeficiency virus (HIV), Hepatitis B and C.[3] In some reports in literature, the rate of needle stick injuries among health care workers handling waste in the hospital setup is reported to be as high as 18% due to improper segregation of waste.[4] NSIs are also reported in the institute with an average of 7-10 incidents per month, 30% of which are while handling waste (HIC records).

In India, the level of awareness about appropriate BMW management practices is found to be wanting. [5,6] Careless disposal of this waste by healthcare establishments can contribute to the spread of hepatitis and AIDS (HIV).[7] A study by Sumi N showed that although the waste generated was being disinfected properly before disposal, the hospital staff was not segregating the waste properly, with resultant delays in lifting of waste compounded with improper disposal.[8] The Biomedical Waste Management rules 2016 has simplified the segregation practices by use of colour codes like Red for infectious plastic waste, vacutainers, Yellow for infectious non-plastic waste, microbiology waste and blood bags, White for sharps and Blue for vials/ampoules and metallic implants.[9]

This brings to therefore the importance of a regular audit of BMW practices at the institutional level not only to prevent mixing of biomedical waste but also to prevent needle stick injuries to the health care workers. Conventional audits require paper documentation as well as communication to different departments which makes it difficult to implement/sustain. On the other hand, a software/app can be used freely as an audit tool. Availability of a mobile app based biomedical waste management audit tool will not only make the complete process of audit easy and paperless but also provide online/offline services to communicate to different departments, facilitate monthly analysis and may improve practices. Electronic and digital information is more flexible, accessible, transferable, and can be more easily stored, summarized, and organized than paper-based information.

There is a growing body of evidence that supports the use of mobile apps in health care interventions.[10] These include the use of apps for smoking cessation [11], exercise and weight management [9,12], and self-management of long-term conditions such as diabetes[13]. Text messaging is being used to provide health education, to issue reminders for appointments, and to improve the efficiency of health systems overall.[10] However, there is relatively little research on the feasibility or effectiveness of downloadable apps or software for mobile phones (specifically smartphones) for the

evaluation of segregation of wastes in a tertiary care hospital.

Our institute is a 2250 bedded, tertiary care, multidisciplinary, teaching hospital. A sample audit was carried out in a single surgical discipline for assessing the utility of the BMW Mobile app as an audit tool for segregation practices where utility of mobile app was measured as reduction in the inappropriate BMW segregation practices along with the ease of conducting an audit.

Materials and Methods

The study was a prospective interventional study. Approval from the Institutional Ethics Committee (IEC) was received before initiation of the study (EC/OA-150/2018). Waiver for consent from participants was granted as the study was based on the utility of mobile app. The confidentiality of the data was strictly maintained. The areas chosen for audit was the surgical discipline consisted of eight wards, one emergency area, one dedicated laboratory and one OPD.

The duration of the study was for three months. The study comprised of three parts, viz; pre training audit (one month) followed by training (one month) and post training audit (one month). The training was provided to all the HCWs of the surgical discipline which included faculty, post graduate students, nursing staff and labour staff. The training consisted of salient features of Biomedical Waste Management rules, 2016 with special reference to colour coding and biomedical waste disposal. All the HCWs were also briefed about the data of the pre-training audit carried out for one month.

Mobile App

An app for evaluating BMW segregation practices was designed with the name BMWM Audit App (Copyright 2019). This app was capable of capturing the entire biomedical waste segregation practices of an institution. The app can be used by the auditor and the administrator with different levels of hierarchy. An administrator can register up to 20 auditors from the same institution. The process consists of registration of the person conducting the audit as an 'auditor' on the app, selecting the area for audit, visiting the area, observing the practices and taking photograph when the practices are inappropriate to be communicated to the unit head of the area. The photographs are automatically sent as an email attachment first to the hospital infection control committee (HICC) which is seen by administrator only. This email was then forwarded to HOD or head of unit of respective area. The photographs clicked on the mobile phone cannot be saved in the auditor's mobile phone and will be available only with the HICC and faculty of respective areas, thus strictly maintaining the confidentiality of the data. The app also provides the compiled area/location/ discipline wise analysis of the BMW segregation practices.

Pre-training audit

All the wards/OPDs/emergency room of the particular surgical discipline was visited twice daily for a period of one month. If segregation was appropriate, the data was stored in the app whereas in case of inappropriate segregation, the photograph along with the details was automatically emailed to HICC which was forwarded to the person responsible for BMW practices in that discipline. After a time span of one month, the data collected over one month was sent to HICC email id captured as a worksheet. This data was further analysed and presented in the form of charts and graphs to the staff members of that department during the training session.

Training session

This training period was kept for one month where HCWs in all the three shifts were trained in small groups on BioMedical Waste

Management rules 2016 and hospital specific policy. As per the rules, undergoing annual training is mandatory for each HCW. This training session included information on Biomedical Waste Management Rules 2016 along with appropriate segregation practices and presentation of audit report.

Post-training audit

After the training session, the audit process was repeated with the BMWM mobile app for the next one month and the data for the same was analysed and compared with the data of pre training. As the mobile app generates the excel sheet automatically, there was no need for case record form to be filled

for the present study. No paper documentation was carried out as the mobile app has been prepared as a paper free audit tool.

The data of pre and post training audit was shared with the head of the respective department and the person responsible for supervising BMW practices in that department.

Statistical Analysis

Data was presented in proportions. The compliance with the segregation practices during pre and post training audit was compared by Chi-square test.

Results

Table 1: Pre-training and post training analysis of audit data.

Advantages of App	Name of Area	Pre-Training			Post-Training		
		T n	A n (%)	IA n (%)	T n	A n (%)	IA n (%)
Discipline Wise	Surgical discipline	1105	1032(93.4)	73(6.6)	1495	1490(99.7)	5(0.3)
Location Wise	Wards	939	873(93)	66(7)	1222	1217(99.6)	5(0.4)
	OPD	59	57(96.6)	2(3.4)	93	93(100)	0
	Emergency Area	61	57(93.4)	4(6.6)	90	90(100)	0
	Lab	46	45(97.8)	1(2.2)	90	90(100)	0
Area Wise	Ward A	126	116(92.1)	10(7.9)	140	139(99.3)	1(0.7)
	Ward B	134	120(89.6)	14(10.4)	141	141(100)	0
	Ward C	76	69(90.8)	7(9.2)	130	130(100)	0
	Ward C	117	112(95.7)	5(4.3)	158	158(100)	0
	Ward E	127	117(92.1)	10(7.9)	165	165(100)	0
	Ward F	106	102(96.2)	4(3.8)	124	124(100)	0
	Ward G	120	109(90.8)	11(9.2)	137	133(97.1)	4(2.9)
	Ward H	133	128(96.2)	5(3.8)	227	227(100)	0
	OPD	59	57(96.6)	2(3.4)	93	93(100)	0
	Lab	46	45(97.8)	1(2.2)	90	90(100)	0
	Emergency Area	61	57(93.4)	4(6.6)	90	90(100)	0
Week Wise	Week 1	385	347(90.1)	38(9.9)	364	361(99.2)	3(0.8)
	Week 2	321	305(95)	16(5)	431	430(99.8)	1(0.2)
	Week 3	272	261(96)	11(4)	379	379(100)	0
	Week 4	127	119(93.7)	8(6.3)	321	320(99.7)	1(0.3)

T- Total observations; A-Appropriate; IA-Inappropriate

The excel sheet generated and emailed by the mobile app for the period of 2 months (pre-audit and post audit) was further analysed. A total of 2600 observations were carried out during the period of two months of audit. Each observation consisted of audit of one bag of any colour or sharp can. The present study analyses Obstetrics and Gynaecology discipline's data. Out of the 2600 observations, 1105 were during the pre-training audit and 1495 during post training audit. Compliance with segregation practices was 93.4% and 99.7% during the pre and post training phase. (p<0.05)

Location wise i.e. wards (8), OPD (1), Lab (1) and Emergency area (1) analysis showed inappropriate segregation practices being highest in wards [66/939; 7%] followed by emergency [4/61;6.6%], OPD [2/59;3.4%] and Lab [1/46;2.2%].

Location wise, Area wise and week-wise analysis of segregation practices is shown in Table 1.

Based on colour coding to be used for segregation, during pre-training audit phase, inappropriate segregation practices were maximum with yellow bags [46/73; 63%] followed by red bag [13/73;17.8%], black bag [9/73;12.3%] and blue bags [5/73; 6.8%]. Compliance with segregation practices of sharp cans was 100%. During post training audit phase, only yellow bag showed inappropriate waste segregation (5/5).

During the pre-training audit, the inappropriate content in yellow bags included gloves (38), non-infectious waste (4), plastic apron (2). Other items found only at one time were like syringes, vacutainer, Urine bag and empty vials. Post training audit, gloves (n=5) were the only inappropriately segregated waste in yellow bags.

During the pre-training audit, the inappropriate contents in red bags were blood bag (4), non-infectious waste (4) and empty

vials (2). Other items included cotton, dressing material, *blood-tinged* cloth and needle which were found to be once.

The inappropriate contents found in cardboard box with blue liner were needle, non-infectious waste, gloves, cotton and mask.

Black bags (presently divided into blue for dry waste and green for wet waste) were recommended only for non-infectious waste but were found to contain inappropriate items like plastic apron (4), gloves (3), diapers (3), disposable mask (2), blood bag (2) and urine bag (1).

The inappropriate segregation of gloves (41) in yellow bag was commonest followed by non-infectious waste (9). Area wise analysis showed that the inappropriate disposal of gloves was commonest in wards (39) followed by RR (2) and OPD (1). Amongst different wards, post-operative ward [9/41;22%] had highest inappropriate disposal of gloves followed by waiting ward [7/41;17.1%]. A total of 145 HCWs were trained during the one-month period consisting of 2 seminars and 22 on-site training sessions at different places and different shifts.

Discussion

The present study is a unique study on paperless audit of biomedical waste segregation practices with the use of a mobile application (copyright 2019). A large number of observations were carried out with the help of this mobile app in a very short period. The time taken for completion of the audit process of one area to reporting the inappropriate segregation practices along with photograph was as less as 5 minutes for each area.

The segregation practices in one of the disciplines of our institute was found to be 93%. Although there are studies about knowledge, attitude and practices about biomedical waste amongst HCWs, there are

very few studies auditing segregation practices in the institute.

The mobile app could provide data in excel format so that there is ease of conducting analysis whether discipline wise, area wise or over all. This facilitated an understanding of the lacunae to improve the segregation practices. Corrective measures were identified which was demonstrated in the discipline mentioned above where the practice improved from 93% to 99%. The mobile app provided targeted approach to improve segregation practices in a particular area.

In the present study, on further analysis, glove was the item which was most inappropriately disposed in yellow bag rather than red bag. Similarly, blood bag was disposed inappropriately in red bag which should have been discarded in yellow bag. This concern was identified during the pre-training audit. The content wise representation gave an idea that the HCWs were confused with the previous BMW management and handling rules where the contents of red and yellow bag were mutually exchangeable.

During the training period, when asked about the reason for inappropriate disposal of gloves, it was mentioned that since gloves tended to be blood tinged in some areas, they were discarded in yellow bag and those gloves which were not contaminated with blood were discarded in the red bag. Hence, training session focused more on appropriate disposal of commonly used items including gloves and blood bag especially in those areas where inappropriate disposal was found to be maximum. During the post-audit phase, improvement in segregation practices was observed. Thus, the mobile is an additional tool for targeted training. As stated by Alvim-Ferraz and Alfonso, inappropriate waste segregation leads to many adverse effects including atmospheric emission of toxic gases.[13] Different studies have shown ways of improving waste segregation practices, the most common being continuous training. [8,11-13] Nataraj *et al* have reported on audit and continuous monitoring with the help of medical students while Escaf & Shurtleff used multi-module approach which included training, audit and continuous monitoring to improve the biomedical waste segregation practices.[10,12] This user-friendly mobile app will be another method to improve the waste segregation practices which is paperless, self-recording and self-analysing.

Audit is a known method of improving practices. But the paper work and difficulty in communication makes regular audits difficult. This study was carried out in a single discipline of a tertiary care teaching hospital. The same can be implemented at the institutional level to have a complete understanding of the audit with the use of mobile app.

Conclusion

The mobile app for audit of biomedical waste segregation practices is a useful tool to carry out paperless audit. The communication to the clinicians including photographic proof about inappropriate waste segregation practices occurs in real time and immediately. Due to the excel format of capturing data, analysis is faster and simpler. Mobile app is a potential tool to improve waste segregation practices.

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