A Systematic Review to Evaluate Knowledge, Attitude, and Practice Regarding Biomedical Waste Management among Dental Teaching Institutions and Private Practitioners in Asian Countries

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Objective: The objective of this study was to assess knowledge, attitude, and practices among dental teaching institutions and private practitioners in Asian countries. Materials and Methods: Systematic review of observational studies on BMW management was conducted. We searched the following electronic bibliographic databases: PubMed/MEDLINE and Google Scholar. Manual search was carried out for similar topics in the National Medical Library, New Delhi. In addition, the bibliographies were manually searched. There was no disagreement between the two reviewers. This review was reported and conducted in step with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Only studies written in English and published until November 2019 were included. This review was registered in International Prospective Register of Systematic Reviews (PROSPERO registration number is CRD42019124900). Results: In this review, of 678 articles, 24 articles met inclusion criteria. Available scientific studies showed that knowledge regarding BMW management guidelines varied from 33% to 100% among dentists. Most of the studies reported that knowledge and practice regarding segregation of BMW was limited. Most of the study subjects were aware of hazardous effects of amalgam and had amalgam separator. Studies done in Chennai and Karnataka, approximately one-third dentists were not following BMW guidelines for sharps management and most of them were disposing of sharps in general waste bins. Conclusion: On the basis of the current evidence and data extracted from the various databases, it can be concluded that knowledge regarding BMW management guidelines among dentists is inadequate and practice regarding the same is poor. Regular training sessions and Continuing Dental Education (CDE) on BMW management guidelines and updates need to be organized for improvement of knowledge and practice regarding BMW among dentists.

Keywords: Asia, attitude, biomedical waste management, dentists, knowledge, practice

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INTRODUCTION

Dental colleges and clinics are those places that have existed since long time in various forms and are increasing more rapidly since the last decade. This increase in dental institutions resulted in a tremendous...
increase in biomedical waste (BMW) generated by these settings. BMW is defined as any waste, which is generated during the diagnosis, treatment, or immunization of human beings or animals or research activities pertaining to the production or testing of biological or health camps, including the categories mentioned in Schedule I appended to these rules.[1] Dental waste is a subset of hazardous BMW, which includes various materials such as soaked cotton, sharp needles, extracted teeth, and human tissue parts that are usually contaminated with body fluids such as blood and saliva.[2] Dental institutions also generate other types of waste such as mercury, silver, amalgam, and various chemical solvents.[3] Amalgam and its waste products need to be strictly regulated otherwise it may lead to environmental pollution as well as occupational hazards.[4] Waste generated in a dental teaching hospital is similar to that generated by other hospitals which include a large component of general waste and a smaller proportion of hazardous waste. According to study conducted in Bangalore, total quantity of waste generated was 0.161 kg/dental clinic/day with 0.130 kg and 0.026 kg of infectious and recyclables waste, respectively.[5] Dentists are always at higher risk for getting infections from patients due to exposures to oral secretions that are potential reservoir for many human pathogens.

As per BMW management rules put forth by government, color coding should be followed while disposing waste generated in dental institutions. Healthcare establishments are responsible for segregation, disinfection, and disposal of BMW in an eco-friendly manner.[1] Dentists are therefore expected to be aware of these waste management regulations, also they are expected to follow these regulations to ensure safe disposal of BMW for maintenance of safe and healthy working environment.

There is paucity of studies on BMW management among dental teaching institutions which produce a considerable amount of BMW. This systematic review is aiming to assess the status of BMW management among dentists of Indian as well as other Asian countries working in private clinics or dental teaching institutions. This will help us to understand the broad picture of waste management awareness and practices among dentists and recommend necessary steps to improve it.

Therefore, this review was planned on available literature for reporting knowledge, attitude, and practices (KAPs) among dental teaching institutions and dental practitioners in Asian countries.

**Materials and Methods**

The protocol of this systematic review protocol was registered in International Prospective Register of Systematic Reviews (PROSPERO registration number is CRD42019124900.) (https://www.crd.york.ac.uk/PROSPERO/#recordID=124900).

**Eligibility criteria for the studies**

This systematic review was carried out on KAP regarding BMW management among dental teaching institutions and private practitioners in Asian countries. The recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) were followed to report this systematic review. The eligibility criteria were based on PICOS (population, intervention, comparator, outcomes, and study design) strategy.

**Population**

Population of interest in the systematic review was the dental professionals of Asia (dental undergraduate students, dental postgraduate students, dental professors, and dental private practitioners).

**Intervention/exposure(s)**

There was no intervention in this analysis. However, the responses (numbers or proportion) in the form of yes or no to each question of KAP components were evaluated.

**Comparator/control**

Not applicable. There were two groups: one for “yes” component and other for “no” component of each KAP question.

**Types of the study to be included**

Cross-sectional observational KAP studies on BMW management among dental teaching institutions and private practitioners in Asian countries were included. Studies published until November 2019 were included in the study as mentioned in protocol.

**Exclusion criteria for this review**

The exclusion criteria of the study were research studies not conducted in Asia, reviews, articles that were not in English language, and protocols of published studies.

**Search strategy**

A systematic search was performed by three authors independently (PT, BK, and NP) using an electronic search as well as manual method. The electronic search was done with PubMed and Google scholar databases. Search strategy used the subject headings and keywords (medical waste disposal, BMW, dental waste, KAP, dentists, dental practitioners, Asia). Boolean operators such as “AND,” “OR” were used for making various combinations of keywords.
The bibliographies of relevant guidelines, reviews, and reports were also inspected to identify further relevant primary reports. A manual search was done from VSPM Dental college library, Nagpur and National Medical Library, New Delhi for gray literature. For studies with data missing or requiring clarification, corresponding authors were contacted. Online search for major conference’s proceedings was also conducted to identify unpublished literature.

**Selection of Studies**

Two authors (PT and BK) individually searched the studies which were included in this review. Initially, exclusion of the studies was done based on titles and abstracts of retrieved studies which were inappropriate. Reference lists of previous reviews were searched for studies that were missed by the electronic search. Full-text articles were retrieved for studies that met inclusion criteria. STROBE checklist for observational study was applied for screening of retrieved articles.

**Collection and Extraction of Data**

This review was done according to the guidelines set forth by PRISMA. Three authors (PT, BK, and BA) were given the responsibility of extracting data from the studies. Prespecified data were extracted from each of the studies including the study design, sample size, knowledge, and practices regarding BMW management among the study subjects. Any kind of disagreement regarding article screening and extraction was sorted out by discussion with other authors (NP and UR).

**Control of Bias Assessment**

**Risk of Bias Assessment**

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used for assessment of risk of bias. Risk of bias or quality assessment was done using four criteria: (1) Study type (2) outcome measures such as KAPs regarding BMW management (3) outcome used for reporting (4) completeness of the information on BMW management. The assessment of risk of bias was performed by rating each of the study criteria as “yes” (low risk of bias), “no” (high risk of bias), or “can’t say” (uncertainty over the potential for bias). The risk of bias assessment was conducted by one of the reviewers and also cross-checked by the other.

**Results**

**Description of Selected Studies**

The original search identified 744 studies and only 24 studies were potentially eligible for the systematic review after performing necessary exclusions [Figure 1].

The study population of 24 identified studies comprised of private and government dentists and only five studies consist paramedic staff in addition to dentists. Most of the studies (21) were conducted in India and remaining studies were conducted in Pakistan, Nepal, and Palestine. In this review, all the studies were of cross-sectional type and most of them used a semi-structured, validated interview schedule for collecting information from participants [Table 1].

In 24 quantitative studies, primary tool consists of structured questionnaire that consists questions regarding KAPs regarding BMW management.

**Awareness Regarding Biomedical Waste Management Guideline**

Knowledge regarding BMW management guideline was highest (100%) in the study done by Narang et al. among dentists of Punjab and lowest knowledge (33%) was seen in study done by Bala et al. in Rohtak. Majority of studies reported that more than 50% dentists were aware about BMW policy set by government. In a study done by Muntaz et al. in Pakistan, 56.5% were having limited knowledge regarding amalgam waste management policy [Figure 2].

**Segregation of Biomedical Waste**

Most of the studies reported that knowledge and practice regarding segregation of BMW was limited. Sood et al. in their study done in Delhi reported that 100% dental practitioners were aware about segregation of waste but only 67% were practicing segregation in routine practice, whereas in a study done by Kesavan et al. in Chennai 14.8% dentists were not aware about different categorization of BMW and 82.4% were not segregating BMW in practice. Singh et al. in their study done among dentists of Uttar Pradesh found that 40.6% were not aware about different color coding of BMW and 86.2% were not segregating BMW as per rule in their clinics.

**Categorizing of Biomedical Waste and Disposal of Sharp**

Categorization of BMW and disposal in color-coded dustbin is utmost important part of BMW management rule but many studies reported that it is not followed up to the mark in private and government settings. A study done by Narang et al. in Punjab reported that 85% dentists were aware of BMW color coding but only 60% dentists were practicing it. Sushma et al. in their study done among private dental practitioners of Karnataka reported that 45.8% dentists used different color-coded containers and only 43.8% used puncture-proof containers for disposal of sharps. Abhishek et al. reported that of 186 private dentists of Karnataka 24.4% disposed sharps into general waste bins. A study
done in Chennai by Kesavan et al.[24] found that 28% dentists were not aware of categorizing of waste, 24.4% dentists used needle destroyer, and only 16.4% dentists used color-coded bags for disposal of BMW. Similar finding was reported by Singh et al.[19] in which 40.6% dentists of 200 were not aware of color coding and 31.9% dentists disposed sharps into the common bin [Figure 2].

**Segregation and disposal of dental amalgam**

Use of dental amalgam is very common practice in dental setup. As it contains mercury, proper segregation and disposal is warranted to avoid hazardous effects of mercury on human health. Most of the study subjects were aware of hazardous effects of amalgam and had amalgam separator. Khatib et al.[10] reported that most of dentists did not follow proper segregation of dental waste and mercury-containing amalgam and generally used to dispose amalgam in general waste. In a study by Sood et al.,[12] 55% dentists used amalgam separator, whereas 81.2% dentists used amalgam separator in a study by Mumtaz et al.[9] Khandelwal et al.[3] reported that only 8% dentists used amalgam separator.

Majority of the dentists (69%) were aware of mercury spill management as reported in a study by Abhishek et al.[23] in Karnataka whereas Bangennavar et al.[21] reported that only 29% dentists were aware of mercury spill management.

**Knowledge, attitude, and practice of biomedical waste management among auxiliary staff**

Some studies reported knowledge and practices of auxiliary staff along with the dentists in their study. Majority of study findings showed that auxiliary staff had poor knowledge of BMW guidelines and practically also they were not following BMW guidelines strictly.[2,14,18,21]

**Quality assessment**

Across the six quality domains evaluated, majority of studies met four or more of the quality criteria. Two studies met all the quality criteria assessed. Twelve studies did not mention how they reached sample size and it was not based on prestudy considerations of statistical power. None of study described methods used to address potential bias. All studies gave a summary of results at the end [Table 2].
### Table 1: Characteristics of studies included in systematic review

| Authors            | Year of publication | Study population                      | Sample size | Study area                  | Outcome measure                                                                 | Results                                                                                                                                                                                                 |
|--------------------|---------------------|----------------------------------------|-------------|-----------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kishor et al.      | 2000                | Dentist                                | 64          | Delhi, India                | Awareness and practice about biomedical waste management                      | Most of them were not aware of BMW management and 50% were practicing proper waste management method                                                                                                   |
| Sudhir et al.      | 2006                | Dentists                               | 302         | Karnataka, India            | Awareness and practices about dental waste management                           | 73% were aware about categorization and color coding of waste, 55% did not have knowledge about hospital waste management policy, 18% were following improper practice for amalgam waste management. Others (94%) disposed in trash, down the sink. |
| Mumtaz et al.      | 2008                | Dentist                                | 239         | Islamabad and Rawalpindi, Pakistan | Knowledge and practices regarding amalgam waste management.                    | 90% perceived amalgam as health risk, 46% considered it as environmental hazard and Only 6% used amalgam separator.                                                                                 |
| Al- Khatib et al.  | 2008                | Dentist                                | 97          | Palestine                   | Awareness regarding dental solid waste management                              | 64% did not segregate BMW before disposal, 48% hand over waste directly to street garbage collector and 42% did not had knowledge about BMW waste segregation                                                                 |
| Sudhakar et al.    | 2008                | Private dental practitioner            | 432         | Bangalore                   | awareness and practices of dental waste management                             | 60–75% participants had awareness about hazardous nature of BMW and its management regulation, 32% participants disposed waste into general garbage and 39% disposed amalgam in dustbin and 6% in drain. |
| Sood et al.        | 2010                | Dental students, faculty of dental college and private practitioner | 100         | Delhi, India                | Knowledge, attitude and practices in disposal of BMW                           | 100% dentists and 12% staffs aware about BMW management rules, 82% dentists and 12% staffs aware about hospital waste management policy and 52% dentists and 20% staff members dispose BMW properly |
| Sushma et al.      | 2010                | Private dentist                        | 96          | Mangalore, India            | Awareness, attitude and practice regarding dental solid waste management       | 98% were aware of waste management policy and 48% handed over waste to municipal garbage collector                                                                                                 |
| Narang et al.      | 2012                | Dentists, auxiliary staffs             | 160         | Punjab, India               | Awareness and practices about dental waste management                          | 71% use boiling water as sterilization medium and 69% disposed hazardous waste into municipality bins                                                                                                  |
| Singh et al.       | 2012                | Dentist in dental hospitals            | 800         | India                       | Knowledge, attitude and practices for cross infection control procedure         | 54% dentists, 83% attenders and 38% auxiliaries had knowledge about segregation of BMW waste management                                                                                                  |
| Sushma et al.      | 2012                | Dentists, auxiliaries and attenders    | 272         | Karnataka, India            | Knowledge about BMW management                                                  | 14% were aware of categories of BMW waste and 26% disposed it wrongly                                                                                                                                |
| Bansal et al.      | 2013                | Private dental practitioner            | 100         | Chandigarh                  | awareness and practices of dental waste management                             | 36% nurses had poor knowledge regarding BMW disposal and Only 15% Class IV staff had good knowledge for it.                                                                                           |
| Sharma et al.      | 2013                | staffs of Jaipur Dental college        | 144         | Jaipur, India               | awareness regarding biomedical waste management policy and practices           |                                                                                                                                                                                                        |
| Authors                  | Year of publication | Study population                              | Sample size | Study area          | Outcome measure                                                                                   | Results                                                                                                                                                                                                 |
|-------------------------|---------------------|------------------------------------------------|-------------|---------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Khandelwal et al.       | 2013                | Dental practitioner                          | 105         | Indore, India       | Knowledge, attitude and practice regarding dental solid waste management                        | 42% dentists dumped BMW in corporation bin, 37% dumped in authorized waste collection site and Only 11% doctors believed that they have role in segregation and 23% practitioners disposed sharps with solid waste |
| Bala et al.             | 2013                | Medical personnel of dental college          | 116         | Rohtak, India       | awareness regarding BMW management                                                              | <30% doctors and no single student knew about BMW management legislation and 45% doctors knew about segregation                                                                                       |
| Singh et al.            | 2014                | Private dental practitioner                  | 200         | Uttar Pradesh, India| Awareness regarding dental waste management rules                                               | 64% dentists were not aware of different types of BMW and 41% disposed amalgams by throwing into common bins                                                                                             |
| Arora et al.            | 2014                | Dentists                                     | 100         | Chhattisgarh, India | KAP about dental waste management                                                                | 48% had knowledge about waste management and only 8% used amalgam in the recommended manner                                                                                                           |
| Bangenavar et al.       | 2015                | Dentist, auxiliary staff and attenders in dental clinic | 158         | Karnataka, India    | KAP about dental waste management                                                                | 29% dentists and 1% attenders identified different color coded bags and 48% clinics had needle destroyer, 71% dentists and 92% dental attenders responded that developer and fixer can be drained into the sewer |
| Rajeev Ranjan et al.    | 2016                | Dental students                              | 500         | Odisha, India       | Awareness about BMW management                                                                  | 44% were not aware of BMW management. 61% were completely unaware regarding recycling and reusing of BMW                                                                                           |
| Abhisek et al.          | 2016                | Private dentists                             | 186         | Karnataka, India    | Knowledge and practices about dental waste management                                           | 86% had knowledge about waste management and 68% handed over BMW to biomedical waste management agency                                                                                                   |
| Kesavan et al.          | 2017                | Dentist                                     | 250         | Chennai, India      | awareness regarding BMW management                                                              | 28% were unaware about different types of color coding for BMW and 28% were unaware of BMW management policy                                                                                      |
| Singh et al.            | 2018                | Undergraduate dental students                | 434         | Nepal               | Awareness of biomedical waste management                                                         | 92% students had positive attitude towards BMW management and only 50% of the students were aware of guidelines.                                                                                     |
| Kumar et al.            | 2018                | Dental students                              | 109         | Lucknow, India      | KAP about dental waste management                                                                | 43% had adequate knowledge about BMW management                                                                                                                                                |
| Raghuvanshi et al.      | 2018                | Private dentist practitioner                 | 614         | India               | Knowledge, attitude and practices in disposal of BMW                                              | 80% private practitioners were aware of BMW categories and >41% practitioners disposed BMW directly into sewer.                                                                                     |
| Jamkhande et al.        | 2019                | Dentist                                     | 200         | Pune, India         | KAP about dental waste management                                                                | 95% were aware of dental waste management and 73%–81% practiced BMW management policy                                                                                                               |
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**Discussion**

We conducted this systematic review on assessment of awareness regarding BMW management rules among dentists because waste management is an important aspect not only for dentists but also for society. We analyzed all domains of BMW management in this review which is depicted in given results. We found that awareness level regarding BMW management among study participants was not up to the mark and there was significant variation in practices of BMW management which could be due to difference in sample size and different study settings [Figure 2]. It was also seen that dentists working in teaching institutions were more aware about BMW guidelines than dentists working in the private set up this may be due to timely training activities in teaching institutions. Most of participants were interested in attending training on BMW management guidelines on a timely manner.[3,18] Private practitioners were not disposing BMW as per guidelines in some places due to lack of authorized BMW recycler in their area or not aware of recycler in the vicinity.[22] Amalgam separator use was low among participants of studies conducted in Uttar Pradesh, Karnataka and Chhattisgarh.[1,19-21] In some studies, paramedical staffs were also included which showed that there was lacunae in awareness and practice of BMW management among these staff.[2,18,21]

Strength of this review is it included studies not only from India but also from other Asian countries. Private practitioners and dental teaching institutions were also included in this review. This review had some limitations like different countries and states had different rules and regulations regarding BMW management which might had affected study results. BMW rules keep changing over the period and studies included in this review were conducted in different time periods which might had effect on results.

**Conclusion**

The result of this review showed that awareness level of the study participants regarding BMW management was low and there was substantial variation in BMW management practices within different studies. Effective management of BMW is important for prevention of hazards related to it as well it is a social responsibility and not mare a legal necessity. Timely training and sensitization programs regarding BMW guidelines are warranted for dentists as well as auxiliary staff to bridge the gap. BMW rules need to be strictly implemented in all health institutions and proper monitoring by concerned authority is necessary for India and other Asian countries.
| Study               | Does the study title and abstract indicate study design summary? | Does the methodology explain study setting, eligibility criteria, selection of participants? | Does the study describe any efforts to address potential sources of bias? | Does study explain how the sample size was arrived at? | Does the study explain all statistical methods? | Does the discussion summarize key results with reference to study objectives? |
|--------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------|
| Mumtaz *et al*     | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Singh *et al*      | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Singh *et al*      | Y                                                               | CS                                                                                         | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Rajeev *et al*     | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Sood *et al*       | Y                                                               | CS                                                                                         | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Raghuvanshi *et al*| Y                                                               | N                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Mumtaz *et al*     | Y                                                               | N                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Singh *et al*      | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Bansal *et al*     | Y                                                               | N                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Y                  | Y                                                               | N                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Sudhakar *et al*   | Y                                                               | N                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Y                  | Y                                                               | Y                                                                                          | Y                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Sharma *et al*     | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Isaam *et al*      | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Sushma *et al*     | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Khandelwal *et al* | Y                                                               | N                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Bala *et al*       | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Kesavan *et al*    | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Jamkhande *et al*  | Y                                                               | Y                                                                                          | Y                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Bangenavar *et al* | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Arora *et al*      | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Sudhir *et al*     | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Kumar *et al*      | Y                                                               | CS                                                                                         | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Sushma *et al*     | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Ahbisek *et al*    | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |
| Narang R *et al*   | Y                                                               | Y                                                                                          | N                                                                        | N                                                   | Y                                               | Y                                                                         |
| Kumar *et al*      | Y                                                               | Y                                                                                          | N                                                                        | Y                                                   | Y                                               | Y                                                                         |

Y = Yes, N = No, CS = Can’t say
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There are no conflicts of interest.

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DATA AVAILABILITY STATEMENT
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