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**ORIGINAL ARTICLE**

# An Institutional Study on Knowledge, Attitudes, and Practices Related to Biomedical Waste Management Among the MBBS and Dental Interns

Aarthi Saravanan,[1,*] Yogeshwaran D,[2] M Vinoth Kumar,[1] P Priya[1] and R Buvaneshwari[1]

[1]*Department of Community Medicine, Sri Venkateswaraa Medical College Hospital and Research Institute, Chennai, India*
[2]*Department of Public Health, Sri Ramachandra Institute of Higher Education and Research, Chennai, India*

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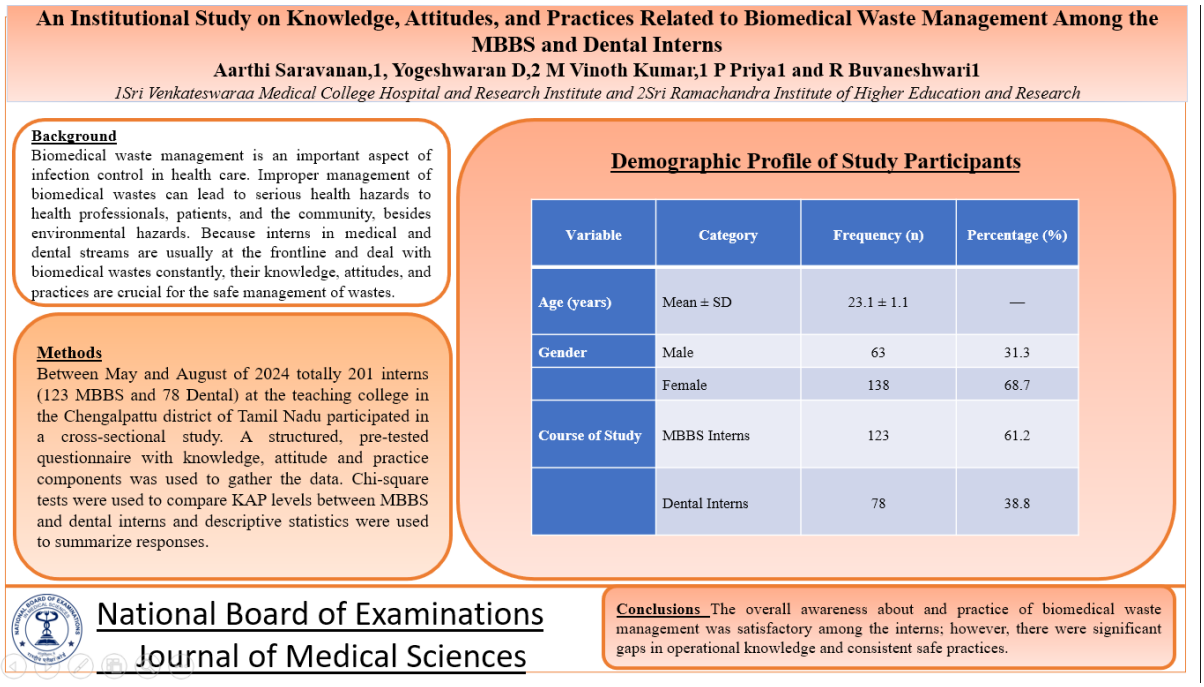
## Abstract

**Background:** Biomedical waste management is an important aspect of infection control in health care. Improper management of biomedical wastes can lead to serious health hazards to health professionals, patients, and the community, besides environmental hazards. Because interns in medical and dental streams are usually at the frontline and deal with biomedical wastes constantly, their knowledge, attitudes, and practices are crucial for the safe management of wastes. **Objective:** To assess the knowledge, attitudes, and practices related to biomedical waste management among medical and dental interns in a teaching institution. **Methods:** Between May and August of 2024 totally 201 interns (123 MBBS and 78 Dental) at the teaching college in the Chengalpattu district of Tamil Nadu participated in a cross-sectional study. A structured, pre-tested questionnaire with knowledge, attitude and practice components was used to gather the data. Chi-square tests were used to compare KAP levels between MBBS and dental interns and descriptive statistics were used to summarize responses. **Results:** Good knowledge was observed in 78.9% of MBBS interns as compared to 42.3% of dental interns, which is statistically significant ($p < 0.001$). Positive attitude was observed in 63 MBBS interns and in 60 dental interns, and the intergroup difference was statistically significant ($p < 0.001$). Good practice was followed by 75.6% of MBBS interns and by 57.7% of dental interns, which is again statistically significant ($p < 0.001$). Waste segregation practices and needle disposal practices were found to be satisfactory, but the use of PPE and knowledge about the duration of waste stored were very unsatisfactory. **Conclusion:** The overall awareness about and practice of biomedical waste management was satisfactory among the interns; however, there were significant gaps in operational knowledge and consistent safe practices. Increased practical training, refresher sessions periodically, and continuous monitoring throughout the internship period are recommended for ensuring safety and effectiveness in biomedical-waste handling in health institutions.

**Keywords:** Biomedical waste management, Knowledge attitude and practice, Medical interns, Dental interns, Infection control

*Corresponding Author: Aarthi Saravanan
Email: aarthi.saran95@gmail.com

**Graphical Abstract**




## Introduction

Biomedical waste includes all kinds of wastes generated from medical activities including those from healthcare institutions, research facilities, and laboratories. Compared to general waste, biomedical wastes pose a much greater risk for injury and infection since they could be carriers of pathogens, chemicals and other hazardous materials [1]. This is one category of wastes whose management is considered of paramount importance to avert serious health and environmental implications. It is estimated that approximately 15% of total wastes generated in healthcare facilities are hazardous, infectious, toxic, or radioactive [2]. Thus infectious wastes would include body fluids, sharp objects contaminated with them laboratory items, pathological wastes as well as single-use disposable items contaminated with agents that may be noxious.

Improper management of biomedical waste may lead to severe adverse effects not only to human health but also to the environment. This includes risks like the release of chemical or biological hazards into the environment and the dissemination of drug-resistant microorganisms. This could further lead to major public health problems such as the spread of infections and contamination of natural resources. Thus, proper disposal and management of biomedical wastes are highly necessary to ensure safety for the patients, health professionals and the community in general.

It was only in 1998 that biomedical waste management was recognized to be of grave importance when regulations were introduced for the first time in India. These laid down a codified framework for safe handling and disposal of BMW. Then came subsequent modifications towards improving the methodology of handling and assimilating better international standards for compliance. More recently the Government of India issued the detailed guidelines in 2016 and 2018 referred to as the BMW Management (BMWM) Principle Rules and BMWM Amendment

Rules, respectively [3]. These provided a step-by-step method for the management of BMW segregation, collection, transportation and storage followed by treatment by autoclaving or incineration before final disposal [4].

Segregation separates hazardous waste from general waste at the generation site to prevent cross-contamination. Collection is defined as a process in which the segregated waste is collected through a systematic gathering for safe transport. Waste transportation should move the waste from the place of generation to the treatment or disposal facility without causing any spillage and resultant exposure. Storage involves the keeping of the waste for a temporary period in specified areas until it undergoes treatment. Finally, treatment in most cases involves either autoclaving or incineration that seeks to neutralize the harmful properties of the waste before its final disposal [5]. Any deviation or improper handling along this chain leads to severe health and environmental hazards.

The importance of effective BMW management extends beyond pressing environmental and health issues. Medical interns and other healthcare workers experience long-term health issues and occupational hazards as a result of BMW management's poor training and practices. Early career practices become deeply rooted habits that can be challenging to break later in life. This emphasizes how crucial it is to teach good waste management techniques from the beginning of medical education.

Interns are starting to move from classroom theory to real-world application in clinical settings at this point in their professional development. Both patient safety and environmental protection depend on their comprehension of and adherence to BMW management procedures. Therefore, the study evaluates medical interns' knowledge, attitudes and practices regarding BMW management in order to identify knowledge and practice gaps, assess attitudes regarding BMW management and provide insight into how well current training programs enable respondents to manage BMW safely. This information will therefore aid in the creation of more effective teaching methods and enhance BMW management techniques among aspiring medical professionals. To assess the knowledge, attitude and practice of biomedical waste among medical interns in teaching colleges

**Methods**

This is a cross-sectional study conducted for three months from May 2024 to August 2024, among the medical and dental interns of a teaching college in Chengalpattu district Tamil Nadu. All interns who had completed their final MBBS or BDS examinations and were posted for compulsory rotatory internship during the study period were included in the eligible population. Exclusion criteria: All interns unwilling to give consent were excluded.

There were 150 interns in the institution of whom 150 MBBS interns and 78 dental interns volunteered and met the inclusion criteria, giving a total sample of 201 participants. Institutional Ethics Committee approval was obtained prior to the start of the study. The participants were recruited by a complete enumeration method. Informed consent was obtained from all the respondents.

Data were collected through a structured, pre-tested questionnaire containing three components. The first

component elicited information on the sociodemographic profile. The second one was to assess knowledge, attitude and practice related to biomedical waste management. The knowledge section included questions on biomedical waste management rules, colour coding, methods of treatment and disposal of waste. The attitude portion measured perceptions about responsibility, workload, safety, etc. The practice section included items on segregation, colour coded disposal, use of PPE, needle disposal, reporting of sharp injuries and training received. Before administering the questionnaire, the purpose of the study was explained and strict confidentiality of the response was ensured.

Knowledge scores were categorized as good knowledge (a total of ten or more correct responses) and poor knowledge (less than ten correct responses). Attitude scores were categorized as either positive or negative based on favourable or unfavourable responses towards BMW management. Practice was categorized as good practice if interns correctly reported at least two core components for safe handling of BMWs, segregation, use of PPE, proper needle disposal, and reporting of injuries. Those that reported less than two safe practices were categorized as having poor practice.

All responses were entered on Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). For the purpose of data analysis, categorical variables were summarised as frequencies and percentages, whereas continuous variables were expressed as mean ± standard deviation. The association between knowledge, attitude and practice levels with the field of study (MBBS or Dental) was assessed by the chi square test. A value of $p< 0.05$ was considered to be statistically significant.

**Results**

This study is done to evaluate the knowledge, attitude and practice of medical interns towards biomedical waste management

Table 1. Demographic Profile of Study Participants

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| **Age (years)** | Mean ± SD | 23.1 ± 1.1 | — |
| **Gender** | Male | 63 | 31.3 |
| | Female | 138 | 68.7 |
| **Course of Study** | MBBS Interns | 123 | 61.2 |
| | Dental Interns | 78 | 38.8 |

Table 1 shows that the sample comprised 201 interns with a slightly higher representation of females 68.7% as opposed to 31.3% males. The average age for the respondents was 23.1 years showing a fairly homogenous age group which is expected from newly graduated medical and dental interns. The MBBS interns were in the majority at 61.2% while dental interns comprised 38.8% of the sample. This is indicative of the institutional composition during the study period and offers an even distribution to evaluate knowledge, attitudes and practices regarding biomedical waste management in both the medical and dental streams.

Table 2. Frequency Distribution of Knowledge Component of the Study Participants

| S.No | VARIABLE | MBBS Correct | MBBS Wrong | Dental Correct | Dental Wrong | MBBS % Correct | Dental % Correct |
|---|---|---|---|---|---|---|---|
| 1 | Awareness of BMW management rules | 121 | 2 | 72 | 6 | 98.40% | 92.30% |
| 2 | Types and sources of BMW | 119 | 4 | 66 | 12 | 96.70% | 84.60% |
| 3 | Health hazards associated with BMW | 116 | 7 | 68 | 10 | 94.30% | 87.20% |
| 4 | Human anatomical waste disposal | 96 | 27 | 46 | 32 | 78.00% | 59.00% |
| 5 | Catheter & urine bag disposal | 99 | 24 | 36 | 42 | 80.50% | 46.20% |
| 6 | Needles, scalpels & blades disposal | 116 | 7 | 56 | 22 | 94.30% | 71.80% |
| 7 | Ampoules & metallic implants disposal | 107 | 16 | 49 | 29 | 87.00% | 62.80% |
| 8 | Biohazard symbol identification | 109 | 14 | 65 | 13 | 88.60% | 83.30% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | Need to disinfect waste before disposal | 118 | 5 | 73 | 5 | 95.90% | 93.60% |
| 10 | Human tissues & organs treatment | 100 | 23 | 47 | 31 | 81.30% | 60.20% |
| 11 | Treatment method for catheters & urine bags | 37 | 86 | 19 | 59 | 30.10% | 24.30% |
| 12 | Maximum storage time for BMW | 18 | 105 | 8 | 70 | 14.60% | 10.30% |
| 13 | Universal precautions followed | 121 | 2 | 70 | 8 | 98.40% | 89.70% |

Table 2 shows that MBBS interns consistently performed with higher knowledge on most domains of biomedical waste management compared to Dental interns though there is considerable variation within both groups on specific topics. Overall awareness about the regulations concerning BMW, sources of origin and resultant health hazards among the two cohorts is good reflecting a strong grasp of concepts. However there is a significant decline in accuracy on items that involve practical application of colour coding and disposal of specific waste categories with particularly low scores amongst Dental interns on catheters, urine bags, sharps and metallic implants. Performance is poorest on knowledge of treatment methods for some categories of waste and maximum permissible storage time for biomedical waste where both cohorts scored low. These reflect poor familiarity with day-to-day operations crucial for daily compliance and infection control. There is reasonable awareness of universal precautions and the need for disinfection but the overall pattern reflects a requirement for more systematic hands-on training in BMW to improve practical competencies and assure compliance with regulatory norms.

Table 3. Frequency Distribution of Attitude Component of the Study Participants

| S.NO | CHARATERISTICS | VARIABLE | MBBS | DENTAL | FRE-QUENCY | PER-CENTAGE (%) |
|---|---|---|---|---|---|---|
| 1. | BMW management is an important issue and must be strictly followed | Strongly agree | 33 | 18 | 33 | 26.8 |
| | | Agree | 1 | 3 | 1 | 0.8 |
| | | Neutral | 3 | 10 | 3 | 2.4 |
| | | Disagree | 77 | 10 | 77 | 62.6 |
| | | Strongly disagree | 9 | 19 | 9 | 7.3 |
| 2. | All healthcare staff are responsible for BMW management and segregation | Strongly agree | 44 | 29 | 44 | 35.8 |
| | | Agree | 2 | 11 | 2 | 1.6 |
| | | Neutral | 6 | 5 | 6 | 4.9 |
| | | Disagree | 65 | 16 | 65 | 52.8 |
| | | Strongly disagree | 6 | 14 | 6 | 4.9 |
| 3. | Colour coding system is a simple method of segregation of BMW | Strongly agree | 53 | 36 | 53 | 43.1 |
| | | Agree | 1 | 11 | 1 | 0.8 |
| | | Neutral | 6 | 14 | 6 | 4.9 |
| | | Disagree | 57 | 28 | 57 | 46.3 |
| | | Strongly disagree | 6 | 9 | 6 | 4.9 |
| 4. | Biomedical waste management increases financial burden on hospital | Strongly agree | 19 | 11 | 19 | 15.4 |
| | | Agree | 38 | 26 | 38 | 30.9 |
| | | Neutral | 46 | 29 | 46 | 37.4 |
| | | Disagree | 5 | 8 | 5 | 4.1 |
| | | Strongly disagree | 15 | 9 | 15 | 12.2 |
| 5. | Biomedical waste management is an extra burden on work | Strongly agree | 15 | 14 | 15 | 12.2 |
| | | Agree | 55 | 26 | 55 | 44.7 |
| | | Neutral | 27 | 19 | 27 | 22 |
| | | Disagree | 4 | 2 | 4 | 3.3 |
| | | Strongly disagree | 22 | 18 | 22 | 17.9 |
| 6. | Willing to attend educational programme on BMW management | Strongly agree | 62 | 29 | 62 | 50.4 |
| | | Agree | 3 | 11 | 3 | 2.4 |
| | | Neutral | 37 | 14 | 37 | 30.1 |
| | | Disagree | 17 | 35 | 17 | 13.8 |
| | | Strongly disagree | 4 | 5 | 4 | 3.3 |

The attitude of the interns regarding BMW management also showed a marked variation. Only 33 respondents 26.8% strongly agreed that BMW management and the need for strict adherence to rules are important while a large majority of 77, 62.6% disagreed with it. The pattern of response was similar regarding perceived responsibility 44, 35.8% strongly agreed that BMW management is the responsibility of all the staff working in any healthcare facility while 65, 52.8% did not agree with it. Opinion regarding colour coding was divided, as 53, 43.1% strongly agreed that colour coding provides an easy way of segregation, while 57, 46.3% disagreed with this. Many interns found BMW management a burden: 57, 46.3% strongly agreed that BMW management increases the financial load on hospitals, and 70, 56.9% strongly agreed to additional workload. Encouragingly, there is a willingness to know better: 62, 50.4% strongly agreed to interest in participating in educational programmes on BMW management; 37, 30.1% were indifferent and 21, 17.1% were unwilling. All these trends put together mean that awareness and perceived responsibility are lacking and also reveal a clear opportunity for focused training programs (Table 3).

Table 4. Frequency Distribution of Practice Component of the Study Participants

| S.NO | CHARACTERISTICS | VARI-ABLE | MBBS | DENTAL | FRE-QUENCY | PER-CENTAGE |
|---|---|---|---|---|---|---|
| 1 | 1.Do you segregate general waste from clinical waste? | Yes | 118 | 71 | 189 | 94 |
| | | No | 5 | 7 | 12 | 6 |
| 2 | 2.Do you dispose of BMW waste in specific colour coded containers? | Yes | 121 | 73 | 194 | 96.5 |
| | | No | 2 | 5 | 7 | 3.5 |
| 3 | 3.Do you discard used needle in needle destroyer? | Yes | 102 | 71 | 173 | 86.1 |
| | | No | 21 | 7 | 28 | 13.9 |
| 4 | 4.Do you wear PPE while handling BMW? | Yes | 73 | 48 | 121 | 60.2 |
| | | No | 50 | 30 | 80 | 39.8 |
| 5 | 5.Have you ever undergone training for biomedical waste management? | Yes | 77 | 42 | 119 | 59.2 |
| | | No | 46 | 36 | 82 | 40.8 |
| 6 | 6.Do you record and report needle stick and sharp injuries? | Yes | 109 | 70 | 179 | 89.1 |
| | | No | 14 | 8 | 22 | 10.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | 7.Have you taken vaccination against hepatitis B? | Yes | 119 | 69 | 188 | 93.5 |
| | | No | 4 | 9 | 13 | 6.5 |

Most of the interns followed appropriate BMW handling practices Waste segregation was done by 189 respondents (94%) and 194 respondents (96.5%) used colour-coded containers appropriately. Needle disposal practices were followed by 173 respondents (86.1%) though the use of PPE was considerably lower at 121 respondents (60.2%). Training gaps were apparent with only 119 respondents (59.2%) having received BMW-specific training. Reporting of needle-stick injuries was high at 179 respondents (89.1%) and hepatitis B vaccination coverage was strong with 188 respondents (93.5%) being protected. These findings indicate that while there is a generally favorable level of basic compliance there is a need for improved PPE use and wider training coverage (Table 4).

Table 5. Comparison of Knowledge, Attitude and Practice Levels between MBBS and Dental Interns Using Chi-square Test

| **Component** | **Category** | **MBBS (n = 123)** | **Dental (n = 78)** | **Chi-square value** | **p-value** |
|---|---|---|---|---|---|
| **Knowledge** | Good knowledge (≥10 correct) | 97 (78.9 %) | 33 (42.3 %) | **27.91** | **< 0.001** |
| | Poor knowledge (<10 correct) | 26 (21.1%) | 45 (57.7 %) | | |
| **Attitude** | Positive attitude (favourable beliefs toward BMW management) | 63(55.3%) | 60 (69.0%) | **3.90** | **<0.001** |
| | Negative attitude (unfavourable beliefs | 51(44.7%) | 27(31.0%) | | |

| | | | | | |
|---|---|---|---|---|---|
| | toward BMW management ) | | | | |
| **Practice** | Good practice (Segregation + PPE + Needle disposal + Reporting injuries) | 93 (75.6 %) | 45 (57.7 %) | **7.12** | **< 0.001** |
| | Poor practice (<2 positive items) | 30 (24.4 %) | 33 (42.3 %) | | |

Table 5 presents the comparison of biomedical waste management-related KAP among MBBS and Dental interns indicating that all three domains have statistically significant differences. MBBS interns had higher knowledge (78.9%) compared to dental interns (42.3%) and the difference was statistically significant ($p < 0.001$). A similar trend in practice is evident with MBBS interns showing 75.6% with good practice scores versus 57.7% among dental interns ($p < 0.001$). While the proportion with a positive attitude was higher among MBBS interns, the chi-square test indicates that the overall distribution of attitude is statistically different ($p < 0.001$). Overall MBBS interns consistently score higher in all three elements compared to dental interns indicating better preparedness and compliance with biomedical waste management standards.

**Discussion**

Medical interns are practicing doctors who work entirely in their field and they are also at a very critical juncture of their lives where they shift gear from theoretical implementation to the application of medical knowledge in real practice situations. If medical interns are able to gain sufficient training and exposure regarding BMW management they will implement this knowledge in their practice as doctors later on in their lives. This will ensure that they never fall short of awareness regarding BMW management guidelines thereby leading to effective healthcare practices in a healthier environment for everyone in the long run. As medical interns engage with biomedical waste in different healthcare facilities, assessing their awareness and implementation of this awareness will help understand whether the current programs for training them have been effective or not and what improvements are required in the current waste management practices in healthcare facilities addressing this gap with the help of this current research work itself.

The interns in the current study showed adequate basic knowledge about BMW regulations in line with past studies conducted in West Bengal where 98% of the medical students were aware of BMW regulations [6]. Specific operating knowledge was relatively poor. Just 14.6% of the interns were able to give the correct storage period for BMW. This is very poor compared to the results obtained in Jammu and Kashmir [7] where nearly 60% of the interns were aware of this information. There appears to be deficiencies in the procedural part of BMW handling.

Attitudinal pattern reveal some critical gaps. Even though only 35.8 percent agreed on the responsibility of all healthcare personnel toward BMW management previous studies conducted in Khammam and Navi Mumbai have shown a remarkable level of agreement above eighty percent [8,9]. Apparently there could be some institutional factors in play which affect these perceptions in some way. Although a belief on the financial burden caused by BMW management of 62.9 percent is evident in the findings of previous studies in Jammu and Kashmir a far lower percentage is provided in our study [7].

Secondly generally satisfactory and inefficient practices can be identified from these findings. Both high incidence of this study of segregation use of needle destroyer and use of PPE can be compared to that of Rajkot in terms of similar level of practices [10]. However use of PPE was significantly low compared to that of COVID-19 pandemic in Puducherry (97.7 percent) [11] and recent national studies [12]. These findings form an integral part of an essential safety gap since PPE forms an integral point of preventing occupational exposure.

The training exposure was limited since only 62.6 percent of the internship pupils had completed BMW training. As was indicated by previous research conducted by Saini et al. [9], Mathur et al. [13] and Pandey et al. [14] there was an element of consistency to support the fact that structured training is an essential component for increased knowledge and good practices being practiced. The possibility that training programs conducted are not contributing to practical aspects being indicated by high theoretical knowledge being practiced incompletely.

Overall this research has proved that while knowledge domains are strong comparatively there are deficiencies in attitude and practical inconsistent practices that require designing and implementing effective training approaches. Furthermore emphasis on improving practical training methods, implementing periodic competency evaluation, and maintaining collective responsibility on all counts within the entire health care personnel may translate into improved compliance and prudent practices concerning the disposal of infectious wastage. This research was conducted in a single teaching institution that might restrict the applicability of the findings of this research to general practice. The approach of using a self-administered questionnaire might pose a challenge regarding potential desirable bias within the research that may indicate overreporting of best practices. As a cross-sectional research project, this particular research does not have the ability to quantify knowledge domain or behavior modification. Also in this research direct observation on site did not take place and might have provided more authentic information regarding the practices of BMW management.

## Conclusion

The results from this study have shown that a relatively good level of knowledge and moderate compliance with key practices related to the management of biomedical waste exists in the interns whereas significant gaps are observed regarding knowledge on operational procedures and practices related to consulting and utilizing protection. Attitudinal variability especially on shared responsibility and workload also confirms the importance of reinforcement during internships.

Though the intern showed good practices for trash management and disposal of needles there are still areas of concern regarding PPE use and training opportunities. This reveals that even though knowledge has been created there is still some way to go before implementation is at an optimal level. The internship process should be combined with training and repeated practices so that optimal compliance of medical graduates regarding trash management protocols can be ensured.

## Statements and Declarations

### Conflicts of interest

The authors declare that they do not have conflict of interest.


### Funding

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