Original Article

Access this article online

Quick Response Code:

Website: www.jehp.net

DOI: 10.4103/jehp.jehp_1632_22

Analysis of cognizance and practices of biomedical waste management principle rules among health professional workers in a teaching hospital with special emphasis on COVID-19 pandemic: A critical appraisal on the current state and way forward

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Abstract:

BACKGROUND: Hospital-generated waste materials commonly labeled as "Biomedical waste" (BMW) is a kind of remnant that includes infectious and non-infectious materials and their appropriate disposals are controlled as per the guidelines of Biomedical Waste Management (BMWM) Amendment Rules, 2018, Government of India. Periodic assessment on BMWM among healthcare workers (HCWs) is mandated to ensure quality assurance, which may be helpful during pandemic times.

MATERIALS AND METHODS: The study was conducted with ethical clearance by using a validated questionnaire (using Cronbach's α) covering knowledge, attitude, and practices (KAP) derived based on recent BMWM 2018 guidelines. The responses in context to KAP were checked by the study conductors, appropriate statistical analysis was done and discussed at end of each session.

RESULTS: Nearly 279 HCWs participated in the study and cast their responses. Knowledge and attitude domain on BMWM showed statistical significance whereas varied responses were observed with practices among the health professional workers with health professional physicians having an edge over other HCWs involved in the processes with varying attrition factors.

CONCLUSIONS: The present study proves novelty by extensively analyzing KAP among HCWs on BMWM in general with special emphasis on laboratory biosafety norms. The study emphasizes that BMWM should be a continuous process and that all HCWs handling BMW must undergo regular training and assessment with questionnaire surveys. Multi-tasking and cumulative efforts must be formulated to attain translational synergy in the stream of KAP of BMWM, which could be attained by incorporating BMWM in the health science curriculum.

Keywords:

Attitude and practice, biomedical waste management, healthcare workers, health education, knowledge

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Received: 14-11-2022
Accepted: 29-12-2022
Published: 28-04-2023

How to cite this article: Sri ES, Vaithy KA, Shanmugasamy K, Srinivasan S. Analysis of cognizance and practices of biomedical waste management principle rules among health professional workers in a teaching hospital with special emphasis on COVID-19 pandemic: A critical appraisal on the current state and way forward. J Edu Health Promot 2023;12:136.

Introduction

A hospital is a healthcare institution catering to the medical needs of society and it is visited by people from all domains and sectors irrespective of sociodemographic profile to get treated for their medical illness.[1,2] A healthcare body is composed of doctors, medical staff as well as other healthcare workers (HCWs) broadly termed as "health care providers." Any human activity generates waste in several forms, which may pose potential hazards to mankind as well as to the environment for the present and future generations, thereby warranting appropriate disposal methods.[2]

Hospital-generated waste materials which are commonly labeled as "Biomedical waste" is a kind of remnant disposal either in the form of human tissue or medical utilities that is definitely potentially harmful with infectious nature.[2-4] Biomedical waste (BMW) is any form of waste materials, which is generated during the process of diagnosis especially laboratory procedures, treatment process, and sometimes even immunization of human beings or animals in research activities pertaining thereto or which includes production or testing of biologicals and health camp activities.[1,4] From the administrative perspective, activities involved in handling biomedical waste management (BMWM) are labeled under the category in Schedule I appended to the recent Biomedical Waste Management (BMWM) Rules, 2016 which includes (i) Waste generation, (ii) Segregation and collection of disposals, (iii) Reception and transportation, (iv) Storage and treatment as per guidelines.[1-4]

In general, it has been estimated that nearly 85% of BMW generated in hospitals are non-infectious while the rest 15% are hazardous and infectious.[4,5] Another potential risk is mixing up of this non-infectious waste with infectious contents owing to improper segregation thereby increasing the volume of total hazardous contents. Hence, an effective task is warranted in managing the 15% volume and subsequently solving all the related problems. A census study conducted nationwide by the Central Pollution Control Board of India had shown that nearly 17,000 healthcare facilities (HCFs) in India had seemed to have generated around 500 tons/day of BMW which translates to a figure of 0.5–0.2 kg/bed per day.[2,5,6]

In the modern era, many new innovative laboratory testing facilities and treatment modalities getting introduced now and then had been contributed to an increasing trend in the gross volume of BMWM.[6,7] Earlier methods of waste management like landfilling, incinerations, burial, etc., have become ineffective in managing the huge volume as well as pose a threat to the environment in many instances.[7] The concept of "waste management hierarchy" is solely based on the principle of "3R" - Reduce, Reuse, and Recycle, which is further categorized with the inclusion of "recover and treat."[7,8] Despite many existing regulatory frameworks worldwide, the ground realities still remain grim thereby warranting enriching the healthcare providers including housekeeping sectors with knowledge and practice on BWM.[9]

Apart from environmental hazards, the HCWs dealing with BWM are frequently subjected to infectious hazards such as human immunodeficiency virus (HIV), hepatitis, and tetanus conditions. To curb such adverse health effects on personnel dealing with BMW and in view of general hygiene, the first regulation for proper management of BMW came into existence in the year 1998 in India as notified by the Ministry of Environment and Forest issuing guidelines to all hospitals and laboratories. However, the most efficient and comprehensive guidelines of waste management were commissioned by the Government of India under the title BMWM (Principle) rules, 2016, and BMWM (Amendment) rules, 2018.[2,6,8] These guidelines are enforced with laying penalties as a deterrent to defaulters. BMW guidelines follow the cradle-to-grave approach until the ultimate destination is attained.

The International Clinical Epidemiology Network conducted a survey across the country covering 25 districts including 20 states.[2,9] The results revealed that improper pre-treatment of BMW at the source point and lack of adequate infrastructure were the major challenges. This in turn puts the physicians and HCWs at exposure risk for acquiring infectious conditions. Several studies that have been conducted on analyzing the knowledge, attitude, and practices (KAP) of BMW rules, 1998 and study analysis on BMWM Rules, 2016 and BMWM (Amendment) Rules, 2018 are very minimal, especially in private sector laboratories covering ground-level sewage workers.[2,6-9] Mere teaching about the rules without proper assessment of the depth of understanding may lead to many adverse events concerned with BMW in general as well as in pandemic situations such as the coronavirus disease 2019 (COVID-19) outbreak.

Several research studies and publications done in the laboratory sector include clinical trials and drug research followed by translational research whereas studies on BMWM often go unprecedented.[10] While the recent 2018 BMWM amendment includes many newer entities incorporating various contents under the BMW category, proper protocol and policy on BMWM are essential for every hospital for operating their functionaries as well as mandatory for accreditation

inspections such as National Accreditation Board for Hospitals and Healthcare (NABH) and National Accreditation Board for Testing and Calibration Laboratories (NABL).[11] Hence, keeping the purview of these regulations, the present study was conducted as a part of quality assurance with a novel aim to assess the KAP of the BMWM (Principle) Rule, 2016, and BMWM (Amendment) Rule, 2018 among laboratory technicians, healthcare professionals including housekeeping staff at our tertiary care teaching hospital located in a semi-urban area of South East coastal region of India.[2,12]

Methodology

Study design and setting

The present study was conducted for a period of six months from November 2019 to April 2020 in a tertiary care hospital equipped with 4500 inpatient beds with the majority being from surgical wards.

Study participants and sampling

We have a hospital protocol as an established system of an induction training program on BMWM and solid waste (SW) disposal for all the HCWs including laboratory technicians, physicians who are involved in BMW management in wards and patient's care section, and housekeeping staff who are involved in handling sewage waste management. The training program is scheduled to be conducted at the time of induction and then onwards for 2 h on weekly basis for a period of one and half months, totaling a duration of 12 h. The mode of delivery of training included didactic lectures, group tasks, open discussions, and demonstrations on all aspects of BMWM in both English and local languages.

Data collection tool and technique

An in-house survey pertaining to healthcare waste (BMW and sewage waste management in context to the latest government guidelines) was proposed to assess the existing KAP of the above-mentioned HCWs.

Questionnaire validation: A self-administered, pre-tested, and structured questionnaire with options (close-ended-multiple choice questions) covering three domains - knowledge (11 questions), attitude (10 questions), and practices (6 questions) of BMWM was prepared and circulated to the HCWs [Annexure-1]. The questionnaires were framed with novelty adapted from literature and with assistance from peer experts and validated using a pilot study.[10,13,14] To ensure a better perception of the questions, a mock pilot test constituting of five participants from each group of HCW was conducted before commencing the actual primary study to avoid "sampling bias." The questions were kept simple, clear, and straightforward without any leading questions to avoid bias (response bias).

The aims and objectives were explained to the participants before handing out the questionnaires in the language of their understanding. It was made certain that the language of the questionnaire was modified for distinct understandings, following post-discussion with the trial groups. The participants were ensured that enrolling in the study is solely voluntary and the participant's details will be anonymized (to avoid voluntary bias) and the results of the study will not be used as the employee's appraisal of the work. Responses were checked by one of the study conductors and discussed at the end of each session. Responses of the groups under which knowledge and attitudes were evaluated include (i) Legal aspects and administrative perspectives (ii) Color-coding and appropriate usage of disposal bins (iii) SW disposal management (iv) Sterilization procedures including disinfections (v) Infectious and potential health hazards and their preventive measures.[15] At the terminal moment of the study period, the COVID-19 pandemic happened worldwide which posed major concerns for laboratory personnel and HCWs where the Government of India via the Health Ministry had issued separate guidelines for BMWM and handling during the pandemic times.[16,17] Being an opportune occasion, the KAP analysis was also pursued pertinent to BMW management during pandemic moments in reference to the COVID-19 outbreak.[16,17]

Statistical analysis

The observations and data parameters were tabulated and then entered in a Microsoft Excel sheet (Mac OS) and statistical analysis was done to calculate the *P* value [Chi-square test] using Socscistatistics.com (Manufactured by Unistat Statistics Software) and P value < 0.005 is taken as a significant value. The self-administered questionnaire was validated by a short pilot study using the appropriate statistical tool Cronbach's α which showed a value (Cronbach's $\alpha \geq 9$ is considered significant).

Ethical consideration

Proper institute ethical committee clearance was obtained for conducting the study.

Results

A total of 450 healthcare professional personnel attended the training and orientation program during the study period fulfilling the eligibility criteria. Among those, 279 personnel volunteered to get enrolled as participants in the study and actively cast their responses. Since participation in the study was kept voluntary, many HCWs chose not to take part at their own liberty. At the end of the survey, the responses were collected and

evaluated by the study supervisors. The observations showed interesting responses, which differed among participant groups in varying proportions. Among the 279 participants, 25% (n = 72) were laboratory technical staff, 16.2% (n = 45) were housekeeping and sanitization personnel, 16.2% (n = 45) were doctors, and 42.6% (n = 117) were nurses and allied health students handling laboratory specimens as depicted in Table 1.

The results observed from the responses of the participants in the context of knowledge and attitude on BMWM were tabulated in Table 1. The analysis of the compiled results as a quantum revealed that doctors and nurses were well aware of waste management rules and norms in reference to legal aspects, SW disposal color-coding, sterilization procedures, and preventive and management aspects. Adequate awareness about the knowledge and attitude domain of BMWM among HCWs was reflected in statistical significance with a P value < 0.005 in all the categories. Though the results of BMWM among HCWs as a quantum are reassuring, the knowledge aspects of BMWM among the sanitization and housekeeping personnel were inefficient whereas responses among laboratory technicians were unprejudiced with some scope for improvement.

Even though our hospital has an appropriate and well-developed BMWM system set in place, responses towards the practice of BMWM among HCWs were concerning especially in emphasizing segregation of infectious from non-infectious wastes, leaving a staggering around 38% of HCWs (especially housekeeping staff followed by laboratory technicians) unaware of the prevailing problem. The results from the participant's responses on the practices of BMWM are shown in Table 2. Surprisingly, results obtained from doctors also showed variations at a modest level, especially in the first two domains of practice of BMWM.

As an exceptional add-on, further exploration of BMWM among HCWs was assessed in reference to recent guidelines proposed by the Government of India to be followed in disposing of BMW during the COVID-19 pandemic, which ensued during the final phase of our study duration. Interestingly, though statistical significance was attained, the responses showed

Table 1: Knowledge and attitude among HCWs on Biomedical Waste Management Rules, 2016 and 2018, and Solid Waste rules, 2016

Knowledge and attitude	Laboratory technicians (*n*=72)	Housekeeping staff and sanitization personnel (*n*=45)	Laboratory physicians and doctors (*n*=45)	Nurses handling laboratory samples (*n*=117)	Chi-square	*P*
Legal aspect and administration (%)	27 (38%)	18 (40%)	36 (80%)	56 (47%)	22.6	0.001
Solid waste disposal (%)	45 (63%)	27 (60%)	38 (84%)	45 (39%)	30.8	0.001
Color-coding of disposal bins (%)	63 (87%)	27 (60%)	43 (95%)	99 (84%)	23.3	0.003
Methods of sterilization and disinfection (%)	65 (90%)	36 (81%)	32 (72%)	72 (63%)	26.8	0.001
Health hazards, prevention, and management (%)	48 (66%)	18 (40%)	38 (84%)	52 (44%)	29.1	0.001

Table 2: Practices among healthcare workers in Biomedical Waste Management Rules, 2016 and 2018

Practices	Laboratory technician (*n*=72)	Housekeeping and sanitization personnel (*n*=45)	Laboratory physicians (*n*=45)	Nurses handling laboratory samples (*n*=117)	Chi-square test	*P*
Differentiating infectious from non-infectious waste (%)	54 (74.2%)	32 (72.25%)	32 (72%)	77 (65%)	3.8	0.001
Treatment of laboratory waste before discarding (%)	65 (90%)	28 (63.4%)	38 (84.%)	74 (63%)	13.3	0.004
Reporting of sharp/needle-related injury (%)	54 (74%)	23 (51.5%)	40 (88.8%)	86 (72%)	20.1	0.001
Hepatitis B vaccination (%)	63 (87.4%)	32 (71.2%)	41 (91.1%)	72 (61%)	23.5	0.003
Hand hygiene (%)	65 (90%)	34 (75.5%)	42 (93%)	90 (77%)	10.8	0.001

Table 3: KAP among HCW on BMWM of samples in reference to the COVID-19 pandemic

KAP on BMWM in context to COVID-19	Laboratory technician (*n*=72)	Housekeeping and sanitization personnel (*n*=45)	Laboratory physicians (*n*=45)	Nurses handling laboratory samples (*n*=117)	Chi-square test	*P*
Safe collection samples in reference to recent bio-safety guidelines related to COVID-19	59 (83%)	30 (65.2%)	38 (84.4%)	65 (55.5%)	29.1	0.001
Legal aspect and awareness on recent laboratory bio-safety guidelines issued related to handling COVID-19 suspected samples	38 (53.5%)	12 (26.6%)	38 (84.4%)	55 (47%)	47.7	0.001
Adequate treatment of laboratory waste before discarding (%)	50 (70.4%)	23 (51.1%)	37 (82.2%)	65 (55.5%)	13.8	0.03
Appropriate use of PPE	52 (73.2%)	23 (51.1%)	43 (95.5%)	86 (73.5%)	22.6	0.001

variations in equal proportions among HCWs as shown in Table 3.

Discussion

Appropriate and sustainable management of the disposal of BMW materials had turned out to be a social and legal responsibility of all the personnel supporting and financing the healthcare profession. Effective BMWM is now mandatory for healthy humans and an eco-friendly environment.[1,3,5]

In the year 2012, World Health Organization conducted a survey on the BMWM status of around 24 countries of various geographical regions in Asian countries and West Pacific countries.[1,3,7] The survey analysis included an extensive literature search, a review of published articles in reputed journals, news and magazine articles, and a few other social media sources.[1-3,15] The survey was mainly focused to assess five major streams of BMW such as management and legal aspects, policy guidelines and regulatory authority framework, segregation, training sessions and orientation classes, technical tools implemented, and utilization of financial resources. Fairly satisfactory results were obtained in knowledge aspects whereas training sessions and technical and logistical aspects showed a dip in the assessment results, especially in the Indian sub-continent.[2,16]

The majority of the countries had no or very minimal allocation of financial resources for BMWM.[2,3,16] Hence, the healthcare working management system still remains far from ideal in the majority of tropical and a few West Pacific countries.[17-19] Thus, enhanced backing for the expansion of BMWM systems in the nations is vital to affirm that by the next decade, safe "biosafety systems" are set in place.

In terms of simplified expression, nearly 81% of respondents knew about the color-coding system of disposal leaving behind a staggering figure of 19% majority being sanitation and housekeeping staff once again. In context to knowledge on color-coding of disposal bins, our observations varied significantly with study observations from Bhagawathi *et al*.[20] and Soyam *et al*.,[21] which showed positive responses of only 27% and 25%, respectively.

Similar observations were noted in the aspects of legal administration and hazard management. The present study postulates that with regard to knowledge and attitude, though overall satisfactory responses were obtained, the domain is still lacking among housekeeping and effluent scavengers due to the fact that they confine themselves to getting involved in handling at ground levels of the hospital campus thereby possessing a tendency to neglect in learning the aspects of knowledge and attitude. Hence, regular training sessions and hands-on orientation demonstrations should be mandated at frequent intervals.[20]

Based on the WHO survey report, in recent times more focus has been directed to retard the volume of infectious and contagious biomedical disposals, which could be achieved by proper segregation of BMW at the primary source level onwards.[2,3] Practically in many instances, segregation occurs at the BMW disposal ground off the hospital vicinity which should be stringently discouraged. In the present study, nearly 72% of participants are aware that the key step in differentiating infectious from non-infectious waste is appropriate segregation of disposals which is supposed to be done at the point of origin concurring with the study observations by Bhagawati *et al*.[20]

As a point of worrying concern, only 70% of HCWs are aware of the practice of the pre-requisite of treating laboratory waste disposal before passing it out of the facility. Surprisingly, laboratory technical staff (90%) gave more correct responses than physicians. Though the physicians had an upper hold in the knowledge domain, interestingly the score in the practice domain is almost similar in groups (except housekeeping workers) due to the unforeseen casual approach to BMWM in some instances among the physicians. Among doctors, the majority of correct responses were obtained from laboratory physicians with experience above 5 years whereas doctors with undergraduate qualifications (especially with less than 5 years of experience) scored low. Higher scores were obtained with regard to vaccination due to the mandatory vaccination schedule being practiced in our hospital at the time of the appointment.

Another major observation in the study is the SW disposal where even the nurses and laboratory technical staff scored low and the reason identified is the blue bag bin in disposing of general waste. With regard to SW disposal, no prior studies had been carried out as well as compliance among HCWs and thus we strongly propose to incorporate solid/general waste disposal management in the curriculum of BMWM concurring with studies of Parida *et al*.[10]

Around 52% of housekeeping staff and 72% of laboratory technical staff are aware of the practice of needle stick injury concurring with the observation of Dudi *et al*.[19] whereas abysmal with the study done by Ismail *et al*.[22] Thus, in the event of coming into contact with infectious material or needle stick injury, all HCWs invariably must possess adequate knowledge of management and any aspect which is below par with the expected knowledge and practice is an instant disaster awaiting to occur at any level.[22-25]

For the first time unique of its kind, the Government of India had notified guidelines of BMWM disposal during pandemic times in reference to COVID-19 disease exclusively for laboratory departments which is mandated to strictly adhere by all laboratory personnel.[16,17] Laboratory personnel also being frontline frontiers in diagnosing COVID-19 disease, and their responses pertaining to laboratory guidelines during the COVID-19 pandemic is solacing owing to the reason of anxiety and stringent emphasis by hospital management to adhere to the guidelines.[26,27] The study on recent BMWM among HCWs in reference to COVID-19 management guidelines is the first of its kind at a global call in laboratory medicine and the observations are documented in Table 3.

Several studies had been conducted to assess the KAP of BMW rules proposed in 1998[2,3,13] whereas studies pertaining to the assessment of KAP on BMWM Rules, 2016 as well as recent BMWM (Amendment) Rules 2018 and its compliance are very sparse, especially among the Southern states of the country.[2,26] From the present study, it is evident that though the doctors including laboratory physicians were aware of the importance of the management of healthcare disposals when it comes to the aspects of guidelines and practice, their knowledge is found to be not competent and complete as expected to be.[2,13,26] Whereas the other HCWs like laboratory technicians and sanitation workers owned better practices in disinfection as well as sterilization. Thus, the gravity of the prevailing issue cannot be sided away. The study reveals that the existing challenges of diverse and varied awareness, administrative issues, casual approach and attitude among staff members, poor accountability, and logistics and fund allotments had many impacts on BMWM with evidently visible critical gaps.

The concept of "quality assurance" being the backbone of an efficient hospital system, must be adhered to invariably by all HCWs. Regular questionnaire surveys on BMWM must be conducted for HCWs as a part of quality assessment at regular intervals and employees should be reassured that it is a fact-finding process rather than fault-finding. One of the major aspects of the survey must be the framing of appropriate questionnaires for a better understanding of the study of the quality system. To enhance the awareness and KAP, the curriculum of all medical, nursing, paramedical, and allied health courses should give utmost importance to BMWM incorporating it in the syllabus. If BMWM is routinely followed, all HCWs could be prepared to manage sudden pandemic situations such as COVID-19 scenarios. Assessment of BMWM in reference to COVID-19 guidelines makes the study unique with novelty and exclusive.

Limitations and recommendations

The study was confined only to the study hospital though the objective could be extended wider to other relevant regional domiciles for further exploration assessment and implementation of BMW guidelines as well as in pandemic scenarios. Although the study was mildly skewed towards favoring doctors followed by laboratory technicians, a large number of housekeeping and effluent scavengers who took part in training and orientation programs on BMWM, only 65% of them had participated in the study. Thus, the scope for future tasks includes extensive surveys and frequent visits to hospitals to evaluate and determine the process of collection, segregation, logistics, and appropriate disposal of BMW. Statistical analysis must be carried out on the questionnaire data and parameters for a better understanding of the responses.

Conclusion

The present study proves novelty by extensively analyzing knowledge, attitude, and practice among laboratory personnel and other HCWs on BMWM in reference to recent guidelines with special emphasis on COVID-19 laboratory biosafety norms. The study emphasizes that BMWM should be a continuous process rather than for the purpose of accreditation-oriented inspections and this will aid laboratory staff in handling BMW disposal during the pandemic situation. Housekeeping and other staff involved in handling BMW must undergo regular training and assessment since their attribution rate is much higher in a healthcare facility. Multi-tasking and cumulative efforts must be formulated to attain translational synergy in the stream of KAP of BMWM. We strongly suggest incorporating BMWM in the medical and health science curriculum with added weightage, and regular questionnaire surveys must be commissioned which could provide a wider platform to accommodate additional concerns.

Acknowledgements

Sincere thanks to all laboratory technical staff, HCWs, and all participants. Sincere thanks to Miss. Shraddha Singeri, in aiding in the successful conduction of this study analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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ANNEXURE-I

1. Does the laboratory generates and handles biomedical waste?
   a. Yes b. No
2. If a laboratory or hospital does not comply with the waste management rules proposed by the Central Pollution Control Board, it is liable to the following penalty:
   a. Warning and show cause notice is issued
   b. Fine of Rs. 10,000/- (In Indian Rupee)
   c. Imprisonment to the concerned for up to 6 months
   d. Both fine up to Rs. 1 lakh and imprisonment up to 1-year period
3. Maximum time duration that an infectious biomedical waste could be stored in the healthcare unit:
   a. Up to 12 h
   b. Up to 24 h
   c. Up to 2 days
   d. Up to 3 days
4. In the color-coding system of disposal, blue solid waste bags should be used to put
   a. Cardboard boxes, wrappers
   b. Plastic-infected waste
   c. Infectious dressing or swab (soiled waste)
   d. Syringes and needle
5. What percentage of waste generated in the hospital is infectious/hazardous in nature according to BMW Rules 2016?
   a. 80%–90%
   b. 15%–20%
   c. 60%–70%
   d. 30%–40%
6. What is the percentage of infectious and non-infectious BMW generated in your hospital?
   a. 80%–20%
   b. 85%–15%
   c. 75%–25%
   d. 50%–50%
7. As per your working hospital policy on biomedical waste management, the following color-coded bins with liners are used:
   a. Yellow, blue, red, and puncture-proof container
   b. Blue, red, green, yellow
   c. Yellow, blue, black, and puncture-proof container
   d. Yellow, red, and puncture-proof container
8. Are you aware of incidents of getting infected by biting nails or having food in laboratories
   a. Yes
   b. No
9. The following solid waste can be incinerated except:
   a. Placenta, tissue
   b. Soiled gauze, dressing
   c. Tissues culture, waste from microbiology
   d. Halogenated plastic
10. The following is the ideal method of destructing of all microorganisms including resistant microbial agents:
    a. Disinfection
    b. Antisepsis
    c. Germicidal
    d. Sterilization
11. COVID-19 suspected/positive laboratory samples should be discarded in
    a. Double yellow autoclavable bag
    b. Blue bag
    c. Red bag
    d. None
12. Sample with suspicion or positive for COVID-19
    a. Can be centrifuged

b. Centrifugation should be avoided
c. Can be centrifuged with an N95 mask
d. None of the above

13. BMW disposal for COVID-19 suspected/positive samples should contain the following
    a. Danger symbol
    b. "COVID-19 waste"
    c. No labeling
    d. None of the above
14. Disinfection of laboratory BMW in COVID-19-related samples should be done by
    a. 0.1% surface disinfection
    b. 1% sodium hypochlorite
    c. Both
    d. None of the above
15. Personal protective equipment must be collected in the following bag for disposal
    a. Red bag
    b. Blue bag
    c. Yellow bag
    d. None
16. The concept of rollback of 10% to 1%–2% sodium hypochlorite was proposed in:
    a. BMWM amendment rules, 2018
    b. BMWM rules, 2016
    c. BMWM rules, 1998
    d. BMWM draft rules, 2011
17. How much is the efficacy of hepatitis B vaccination in preventing hepatitis B infection:
    a. 70%–75%
    b. 90%–95%
    c. 40%–50%
    d. 30%–40%
18. Which of the following is the most common means of the spread of nosocomial pathogens?
    a. Central intravenous catheter
    b. Foley's catheter
    c. Peripheral intravenous lines
    d. Hands of healthcare workers
19. The "major key step" to "waste minimization" and appropriate management of biomedical waste is
    a. Incineration of waste, which is infectious in nature
    b. Autoclaving/microwaving infectious waste disposal
    c. Recycling of plastic disposals
    d. Proper segregation at the point of generation
20. If a healthcare worker encounters a needle stick injury, the following are supposed to be followed except:
    a. Immediately suck his/her bleeding finger
    b. Wash with the soap under running water and seek further medical advice
    c. Report to chief medical officer (CMO)/nodal officer casualty
    d. Apply antiseptic dressing immediately
21. Appropriate pre-treatment as disinfection of laboratory waste is done with the purpose of:
    a. Reducing the bulk and disinfecting the waste
    b. Safety of waste handlers
    c. To reuse the item
    d. To store for a long duration
22. Concentration of sodium hypochlorite used for routine disinfection of used disposable items is:
    a. 0.1% for 1 h
    b. 1.0% for 30 min
    c. 5% for 20 min
    d. 10% for 30 min
23. The first step in the processing of reusable instruments is
    a. Cleaning under running water
    b. Washing using soap and water

c. Scrubbing with brush and water
d. Decontamination

24. Masks and gloves for suspected cases of COVID-19/quarantine cases must be kept in a paper box for a minimum of the following duration before disposal
    a. 72 h
    b. 48 h
    c. 24 h
    d. One week
25. Which of the following is the single-most effective way to prevent the transmission of diseases in the hospital?
    a. Prophylactic antibiotics
    b. Hand washing for 20–30 s following six steps
    c. Using disinfectants in hospital
    d. All of the above
26. Schedule of hepatitis B virus vaccination?
    a. 0, 1, 6 months
    b. 0, 1, 3 months
    c. 0 and 6 months
    d. 0 and 1 months
27. During the COVID-19 pandemic, the utilization of treated wastewater in HCF should be
    a. Continued
    b. Avoided
    c. To be stored separately
    d. None