

Conceptual Barricades to Coronavirus Disease 2019 Biomedical Waste Management

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Abstract

Biomedical Waste Management (BMWM) is a major environmental health concern. Coronavirus disease 2019 (COVID-19) pandemic came as bolt from the blue for governance with negligible preparedness. Pandemic COVID-19 has led to generation of solid waste and BMW in large volumes. Such BMW is an additional challenge in COVID-19 situation for health-care facilities supplementary to COVID-19 pandemic management, control, and prevention strategies. The Central Pollution Control Board (CPCB) issued guidelines for COVID-19-related BMW waste in the 3rd week of March 2020 and subsequently revised the same on March 25, 2020, and then on April 18, 2020. Scenario becomes compounded when less literate workers handling BMW are required to develop newer competencies with deficient training and limited timeframe. Lots have been done to prepare COVID-19-related BMW waste management and lots still need to be done to cover all the guidelines including practicality of implementation and ensuring less compromise on quality health care. This article focuses to review the COVID-19-related revised BMW requirements and their critical appraisal.

Keywords: Biomedical waste, Common biomedical waste treatment facility, Coronavirus disease 2019, Training

1. Introduction

Coronavirus disease 2019 (COVID-19) pandemic came as bolt from the blue for governance with negligible preparedness. Policymakers having not anticipated the possible management requirements are struggling to treat the infected on the one hand and to prevent the further spread on the other hand. Ground staff (health-care providers and associated staff) have been struggling to prevent themselves and their dear ones while being assigned to manage the situation amid the scanty scientifically proven literature on presentation and treatment.

Policymakers have been making sincere efforts to frame the situationally appropriate guidelines and updating them more frequently. Such newly framed guidelines need to be translated and reframed in such a manner which is understandable by the least literate ground staff. There is a need for development of master trainer program, followed by ground staff orientation programs. This needs to be done at a speed higher than speeding COVID-19 spread. Barriers exist to competencies development among ground staff on account of their reluctance, deficient training programs, time constraints, and continually changing guidelines. Such barriers can lead to ground staff leading to unintentional infection spread.

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One challenge in COVID-19 situation is infectious waste and more so the way such waste is handled. India now has clear guidelines to deal with coronavirus-related biomedical waste (BMW). Such BMW gets collected by least literate persons with limited capabilities for newer competency development (and in shorter periods) over added by burdening frequently updated instructions.

The Government of India notified BioMedical Waste Management and Handling (BMW/MH) rules in 2016¹ with amendments in 2018 and 2019^{2,3}. Envisaging requirements (including training) for shifting to revised rules, 2-year time period was given for implementing newly notified rule³. BMW is a solid/liquid waste material generated during diagnosis, treatment, and immunization of human beings or animals, during biological handling, at health camps, or during research⁴.

Acquiescence to BMW/MH requires organization's sincere efforts through training and administrative focus³. Biomedical waste needs to be segregated at the generation point to ensure compliance with rules and to minimize health hazards¹. Improper handling and unscientific BMW/MH can lead to cross infection among patients⁴ and have been found as potential causes of infection^{3,5,6}.

BW/MH rules covered BMW generated by health-care service providers, diagnostic laboratories, and research organizations^{3,4}. However, BMW generated from residential houses and other office-based organizations/industries was not covered by rules, probably for insignificant quantity to be misused, low infection transmission possibility, and practical considerations.

The Central Pollution Control Board (CPCB) issued additional guidelines related to COVID-19 waste on March 19, 2020, and subsequently revised on March 25, 2020,⁷ and then Revision-2 was done on April 18, 2020⁸. Amid COVID-19 pandemic, BMW generation increased with personal protective equipment (PPE) use such as gloves, face masks, protective gowns, boots, aprons, and other contaminated materials including paper tissues and disposables. Such increased volume was unlikely to become a matter of concern; had there been no change in rules⁹ and guidelines for segregators and handlers. Health system on the one hand has been dealing with management and pandemic control and on the other hand got further loaded with additional/revised BMW-related requirements.

COVID-19-related health-care waste and potentially infected waste generated by an asymptomatic person during

incubation period are equally serious^{9,10} issues for environmental safety and occupational health. Infectious waste generated from COVID-19 treatment units is another crucial aspect, considering the increased patient load in COVID-19 pandemic and waste generated which needs to be handled, collected, treated, and disposed safely^{11,12}.

Can our waste management systems handle the COVID-19 pandemic?⁶ How efficiently can our existing health-care system take challenges related to new COVID-19 BMW segregation/handling guidelines parallel to COVID-19 pandemic management together? How COVID-19-related BMW requirements can be refined and complied? The authors in this article are not contradicting or opposing the revised BMW requirements. This article focuses to review the revised COVID-19-related BMW requirements and make its critical appraisal with suggestion to realistic implementation.

COVID-19 pandemic led to the following additional/revised requirements for proper BMW by⁸:

- Revision in segregation and handling requirements for hospital
- Wastewater management at health-care facilities (HCFs)
- Requirements from quarantine facilities (camps/homes)
- Requirements from home-care facilities (home isolation)
- Requirements for common biomedical waste treatment facilities (CBWTFs)
- Duties of state pollution control boards (SPCBs)

2. Method

Published official guidelines, news, and other materials were reviewed by the authors. Practical aspects of implementation were discussed with hospital managers and subject experts easily accessible to the authors.

3. Guidelines for HCFs with Isolation Wards

Being critical in the initial phases, tasks related to isolation, management, and treatment of suspected and COVID-19-positive patients were restricted only to public HCFs¹³. This was important to ensure control over disease, critical information flow, disease trend analysis such that nodal agencies assigned for monitoring the

situation, planning, control and prevention-related activities received timely and reliable information¹³. This was also required, as the government has scanty control on private HCFs and could have refused to participate considering the risks involved.

National Quality Assurance Standards¹⁴ have been defined for most public health-care facilities except medical colleges. Public health-care facilities had recently entered into the era where states have awakened to improve their health-care quality levels. Facilities in smaller proportion have been able to reach and achieve a certain level of standard of care in India. Such Quality improvement (QI) focus varied largely between various states, health being a state matter. Infection control practices and health-care workers' (HCWs') safety are important quality accreditation considerations. The term "health-care workers" has been used for health-care workers like doctors, nurses, paramedical staff, and supportive staff. While QI activities had been going on in most public health-care facilities except medical colleges, most if not all the patients were referred to medical colleges for management of suspected and COVID-19-positive patients.

States (with gross variation) have been struggling on achieving desired QI-related output at public HCFs under the sociopolitical situation prevalent at that state. Some states have been progressing at an unexpectedly fast pace on QI activities while others may have dismally low focus. HCWs based on the sociopolitical situation have varied performance levels. It is a well-known fact that the quality of care levels at public HCFs is significantly lower than that at good private HCFs¹⁵. HCWs at public HCFs as such are likely to have lower motivational and job satisfaction levels as compared to those at private HCFs^{16,17}.

Resistance to participate in COVID-19-related health-care activities has been observed among HCWs, especially in the initial stages, which is attributable to ignorance, lack of faith in system, inadequate information on new situation, PPE scarcity, system readiness, overall hospital preparedness, and no structured training/orientation sessions¹⁰. It was like lesser motivated army has been suddenly ordered to fight the unknown enemy in the dark and without appropriate arms and ammunition compounded by subsequent advisory to use methods not taught/practiced earlier.

Public HCFs are known to have inadequate or just sufficient workforce with interstate variation. COVID-19 situation required HCWs to be given 7–14 days rest as quarantine leave, further reducing the staff strength

to half, overadded by COVID-19 fear-related voluntary leave/absenteeism.

In such perceived middle of nowhere situation for HCWs, CPCB issued additional guidelines for COVID-19-related BMW. This was perceived by HCWs as additional liability, and additional training was to be provided by HCFs. On visit to various HCFs, it was observed that middle- and senior-level staff at public HCFs were occupied with COVID-19 reporting and coordination requirements. Lockdown prevented imparting train the trainer program for new BMW requirements. Thus, on-ground HCWs may be still working with scanty or no training on additional requirements by CPCB related to COVID-19.

Some HCWs interpreted the requirement of separate bins as an additional requirement, though it was not an additional requirement. Isolation wards had been identified as one of the few existing wards and thus its segregated BMW fulfilled the requirement for separate bins/bags⁸.

Double-layered bag⁸ requirement is a small add-on with bag in bag to be used instead of a single bag. However, it requires an additional checkpoint for supervisors to ensure double-bag use. Supervision got constrained by limited staff being allowed to enter isolation wards due to limited PPE supply (short in supply initially).

Another mandatory requirement by CPCB was labeling such waste bags as COVID-19 waste³. Sounding small task has differing subjective interpretation by different HCWs, HCFs, and monitoring agencies like SPCBs and pollution control committees (PCCs) in terms like label size, printed labels/handwritten, text size/boldness, and portion to be labeled on bags. Such varying interpretation can lead to exploitation in the hands of environmental engineers/SPCBs/PCCs.

Separate collection center⁸ requirement could have been constraints for HCFs with limited infrastructure/space, limited funds for new construction, and lockdown leading to ban on construction activities. This could have been made optional considering additional labeling requirements, provided the intent of requirement got complied. On the other hand, identifying though separately labeled bags from other bags could pose challenges to lesser literate and capable CBWTF workers⁸ with varying interpretation of labeling by HCWs.

Bin/trolley/container⁸ disinfection requirement posed another challenge to HCFs. With 50% workforce strength (quarantine leave) and varying interpretation, practical implementation by HCF's varied from hypochlorite

solution spray to pouring the solution and getting scrub cleaning by overenthusiastic managers. Such activities could expose HCWs to avoidable contact with harmful chemical to physical injuries depending on bin/container/trolley type and shape⁸.

Separate sanitation worker⁸ requirement again posed a challenge with already reduced workforce situation and could have been left to HCFs' decision based on their hospital size, layout, and functioning while leaving the intent of the requirement intact⁸.

Fecal matter handing, disposal, and bedpan cleaning,⁸ though obviously routine matter at a private hospital, requires to be relooked the way it works at and practical implementation at public HCFs. Public HCWs may not agree to do the same even for non-COVID patients in routine. Relatives are not being allowed to enter COVID-19 isolation wards. And supervisory staff has limited entry to isolation wards.

4. Guidelines for Sample Collection Centers and Laboratories for COVID-19-Suspected Patients

CPCB requires pre-treatment of COVID-19-related laboratory waste⁷. There has been difference in opinion and interpretation about pre-treatment requirements for laboratory wastes¹; this may not be in line with international guidelines¹⁸. BMWMH 2016 required pre-treated waste to be disposed in yellow bags whereas COVID-19 guidelines required pre-treated waste to be segregated into red bags. The authors disagree for COVID-19 waste to be classified as waste for pre-treatment as per the intent and waste type (h) interpretation for yellow bags according to BMWMH 2016. COVID-19 waste is neither more infectious nor culture-related waste as per the intent for waste type (h)¹.

5. Responsibilities of Persons Operating Quarantine Camps/Home-Care Facilities

It is being discussed separately for quarantine camps and home care facilities. Waste generated at quarantine camps has been appreciably kept simple by single-colored bag use. Further revised rule has clearly defined quarantine

camp to avoid confusion during implementation. On the other hand, most of the responsibilities have been rested on the person operating quarantine camp.

Competency/capability levels/training requirements of persons assigned to operate quarantine camp operating away from existing hospital needs to be understood. Under the constrained workforce situation, responsibilities assigned to coordinate and to make it work to such assigned HCW's needs to be considered. Higher offices/officers' preparedness to come down to support needed to be anticipated. It would have been better, if instead, existing office bodies like ULBs/SPCBs/PCCs were assigned for coordination and to ensure that support reached the junior person operating the quarantine camps. Rules are also silent on the financial aspects between CBWTFs and waste generators, which could get exploited in the exigent situation.

Practical consideration in implementation of CPCB guidelines for home care facilities (where patients are at their home) is discussed below. Questions that remain to be addressed include:

1. When and how home care facility will get BMW yellow bags? Who shall be responsible to provide such bags and who shall bear the cost?
2. Under the lockdown situation, how will BMW reach CBWTFs? Is it expected that COVID-19 case contacts shall be allowed to come out to reach the collection agencies or alternatively who shall be responsible to align a team to get BMW collected from home care facility?
3. Who will pay for bags and collection services?
4. Who will and how will it be ensured the BMW is not stored for more than 48 h? While hospitals are restricted to store for more than 48 h and home care facilities are expected to store for 72 h; Logical consideration remains to be explained
5. Who will provide necessary training to non-medical patients on what and how to segregate and handle BMW? In the absence of training, infection spread risk is bound to increase. At hospitals, double-layered bags are expected and waste trolleys are required to be disinfected to ensure that outer of bags does not get infected. Improper handling of BMW at home care facility without due training and orientation may lead to external surface of bags being potentially infectious. When will such training get provided?
6. Hospitals and highest level agencies at international level have been advocating minimal handling of BMW. Requirement of cutting of masks (with scanty training) and without appropriate cutting gadgets; may instead lead to COVID-19 spread.

7. Advice on cutting of masks to prevent reuse may reflect the policymaker's confidence in system created for collection, transport, and treatment of BMW. Policymakers need to ensure robust and dependable collection, transport, and treatment system (fewer to manage) instead of exposing large numbered providers to the risk (mutilation requirement) at point of BMW segregation.

With the above, it is suggested that such component of BMW at home care facility needs to be elaborated in detail and proper responsibilities need to be defined with monitoring mechanism.

News¹⁹ published by various newspapers was reviewed for successful implementation of home collection in Delhi. News contained feedback from ground staff, and it could be interpreted that the Municipal Corporation of Delhi (MCD) had formed their own standard operating procedure (SOP). After initial glitches, MCD has been able to refine the working while ensuring workers' safety. On analysis of news, it could be possible that home care facilities were collecting COVID waste in some bags (non-yellow). MCD staff are spraying hypochlorite on these ordinary bags at doorstep and then placing them into double-layered yellow bags. News on July 9, 2020, mentioned need for awareness on COVID waste among residents, as in its absence, COVID waste was getting mixed with general waste leading to higher risk. Inadequacy of SOP/non-compliance was evident from the fact that 45 sanitation workers had been tested positive till July 9, 2020. Compromise on PPE use could also be attributed to hot and at times humid weather. Sanitation/garbage collection workers had expressed lack of awareness among general population, and it seems that the task on creating awareness has been assigned to garbage collectors who have expressed time constraints in performing the same. From all the news, the authors feel that tasks are being left to be performed by the least literate staff.

6. Duties of CBWTFs

Guidelines on COVID-19 by CPCB required workers to be provided with adequate PPEs⁸. This is important as contractors for CBWTFs being businessmen may compromise on staff safety. Guidelines are silent on additional cost incurred and its recovery mechanism. Hot and humid environments in certain geographical areas might lead to PPE non-use by workers and

money-saving excuse for contractors. Further dedicated vehicle⁸ requirement needs to be reviewed with respect to additional costs incurred and investment recovery to CBWTFs. Furthermore, there shall be additional costs to contractors for hypochlorite spray, additional workforce for spray, and leave to the symptomatic workers. Training issues include shortage of time to implement, workers' educational levels, PPE use, collection from quarantine facilities, and home care.

7. Duties of SPCBs/PCCs

Additional tasks assigned included paperwork, giving permissions, and monitoring. While HCFs and HCWs are busy handling and managing the situation, SPCBs/PCCs could have been assigned to impart training and assigned to ensure on-ground coordination at all levels including ULBs, HCFs, quarantine centers, and home care. Further, in such exigent situation, they could have been assigned to interact and survey the ground-level workers to ensure streamline flow and BMW movement rather than reporting requirements focus.

8. Duties of ULBs

CPCB guidelines cover many foreseen requirements for facilitating collection, transportation, and BMW disposal. ULBs have been assigned task for local level coordination under their jurisdictions. To facilitate HCWs, ULBs have been assigned for doorstep BMW collection, to be handed over to CBWTFs and to provide yellow-colored bags for BMW. Workers' safety aspects have been covered by assigning ULBs to provide necessary PPEs. ULBs have been assigned to ensure training (through CBWTFs) to assigned waste and BMW waste collection workers on BMW handling and sanitization. Many hospitals, even after 4 years of BMW 2016 rule notification, have been struggling to streamline their BMW handling, segregation, and training sessions being provided by CBWTFs. The authors during interaction with various hospital managers observed that there is a need for better training programs and that training given by CBWTFs could be biased toward their own interests. Hospitals have been exploring better training options/training providers. Confusions are bound to happen where training is provided by "A" to "B" and "B" is being inspected by "C." Direct training by SPCBs/PCCs possibly

could yield better results, thus giving them opportunities to understand lacunae and bridging the gap between waste generators, ULBs, and CBWTFs.

9. Management of Wastewater from HCFs/Isolation Wards

Virus (COVID-19) transmission through sewerage systems has been reported as low risk, and there is no evidence about transmission to plant operators. All STP plant operators have been advised to continue to ensure disinfection. PPEs are required to be provided to STP/ETP operators⁸.

Thus additional advice w.r.t to COVID-19 includes, PPE use and to avoid treated water (Clean Gray Water) utilization within the HCFs⁸.

10. Worldwide Scenario versus Indian Scenario for COVID-19 Waste Management

According to the World Health Organization, no evidence of COVID-19 virus transmission has been found while handling health-care waste via direct and unprotected human contact. Health-care waste generated during COVID-19 patients' care should be collected safely in designated bags and containers followed by safe disposal or treated or both preferably on-site. If waste is moved off-site, critical issues arise to understand where and how it will be treated and destroyed²⁰.

According to the Solid Waste Association of North America, there are no specific precautionary measures required to protect waste workers from COVID-19. During handling of municipal solid waste, workers should use routine precautionary measures already in place to protect themselves from the hazards. COVID-19 is not a Category "A" infectious substance. Medical waste suspected or known to be contaminated with COVID-19 should be handled like other regulated medical waste (RMW). Safe work practices should be ensured by approved engineering, administrative controls, and PPE to prevent workers' exposure to medical waste including sharps and other items that can cause injuries or exposures to infectious materials²¹.

As per the California Department of Public Health Medical Waste Management Program, there are no additional regulatory requirements for handling,

marking, storing, transporting, or treatment of medical waste contaminated with COVID-19²².

Provisions of the Texas Commission on Environmental Quality (TCEQ) recommend that medical waste generated from COVID-19 should be handled as RMW, if the waste is generated from a health care. RMW can be treated like other medical waste. It can be treated by a generator on-site, and after treatment, it can be managed as routine municipal solid waste. If the waste is generated outside a health-care facility, such as at home or business area, then TCEQ would recommend the Centers for Disease Control and Prevention (CDC) guidelines, Texas DSHS guidance, and recommendations²³.

As per CDC, COVID-19 is not a Category "A" infectious waste, so medical waste COVID-19 contamination should be managed like any other RMW. Measures should be adopted to protect workers from sharp injury and infectious exposures. There should be assurance of safe work practices and PPE utilization such as puncture-resistant gloves, face mask as well as eye protection. CDC guidance states that the RMW management should be performed in compliance with routine procedures, as there has been no transmission of severe acute respiratory syndrome coronaviruses including COVID-19²³⁻²⁶. CDC guidelines for COVID-19 medical waste disposal conclude that medical waste generated from health-care facilities without COVID-19 patients is not different than waste coming from facilities treating COVID-19 patients. These guidelines also state that management of food service utensils, laundry, and medical waste should be performed similarly to routine procedures. No such evidence exists that facility waste needs any extra disinfection²⁶.

Current wastewater disinfection practices at treatment facilities are sufficient as coronavirus is susceptible to the same disinfection conditions as other viruses such as hypochlorite oxidation (i.e. chlorine bleach), peracetic acid as well as inactivation by ultraviolet irradiation²⁶. There is no evidence for additional COVID-19-specific protections for employees involved in wastewater treatment facilities. However, they should follow routine practices to prevent exposure to wastewater such as safe work practices and PPE normally required when handling untreated wastewater along with engineering and administrative controls^{24,25}.

While this may be true for developed nations, extra precaution may be required for developing nations²⁴⁻²⁶.

11. Discussion

Components remaining to be covered under COVID-19 BMW requirements include:

- Potentially infectious waste generated by an asymptomatic person during incubation period: As per the statistics, more than 80% population getting infected shall be asymptomatic and may not require even medical advice⁸. It needs to be understood that during asymptomatic infection phase till development of immunity, such persons shall continue to shed virus in their secretions²⁷. Waste generated by them could be potentially infectious and a risk factor for waste collection and handling workers and consequent spread may occur. Thus, the revised guidelines probably cover only 15–20% of the potentially infectious COVID-19 virus-related waste
- Guidelines for non-health-care-based organizations, offices, and industries: As the non-health-care offices, organizations, and industries shall open, there shall be movement of employees, service providers, and customers. Movement of asymptomatic persons shedding virus is inevitable. Face mask use has been mandated in public places. Guidelines for non-HCFs need to be released for segregation, storage, collection, transportation, and disposal of such masks
- In the coming time, voluntary and paid COVID-19 testing may be available: Asymptomatic individuals may choose not to disclose their identity to avoid hassles. Provision for waste disposal through CBWTFs for voluntary requesting individuals/non-medical institutions shall also be required.

Health-care managers and experts were of the opinion that COVID-19 tasks, especially patient handling and management at public HCFs, have been getting on the shoulders of junior staff in all cadres. Such junior staff shall be young by age and experience. They are likely to have lower maturity levels and further constrained decision-making powers. Now the situation gets compounded with lower maturity to realize the importance, little control and command, quickly developed situation leading to little training with +/- competence assessment, reluctance on infection transmission fear, and disease contraction.

Similar junior staff have to do survey, screening, sample collection, and reporting also. With so many tasks, obviously some part will get neglected, especially when one is unlikely to be supervised. Another barrier is when common/layman gets quarantined, how much he/she will understand, agree to follow and practical possibility

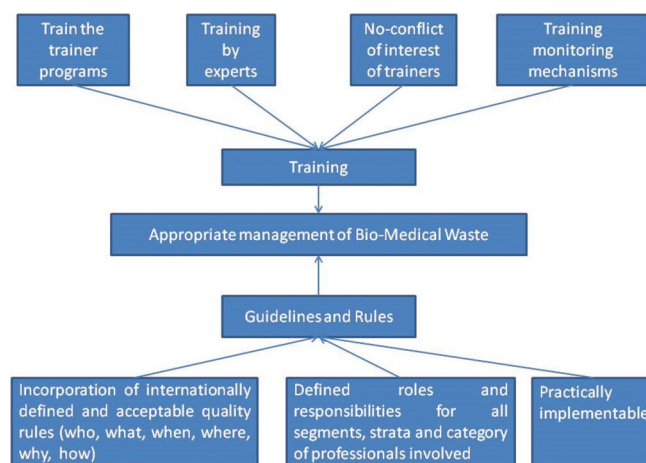


Figure 1. Suggestion for appropriate management of biomedical waste from health-care workers' point of view.

for persons with unknown/unevaluated mental/physical ability.

Another aspect, though not documented in guidelines, is the reporting component. Managers, heads, and implementation agencies tend to become overenthusiastic in data collection without understanding the limitations and constraints at lower levels. It has been observed at times that reporting becomes more important than compliance. Crisis time requires teamwork. Maybe implementing agencies needed to get on ground to understand the reality, provide supportive visits, and collect data rather than focusing on reporting requirements.

12. Conclusion

Quality rules prescribe that guidelines and protocols should cover at least who, what, when, where, why, and how (5W1H) components. Lots of work have been done to prepare the guidelines for COVID-19 waste management and lots more may still be required to cover all aspects (5W1H) to avoid variation and confusion to ground force.

The above is possible only when all inter-related functional and structural aspects are studied. It may require involving ground forces in the decision-making process as well. In addition to well-framed guidelines, specified job responsibilities and collaborative approach may become key to success in crisis times (Figure 1).

International agencies required no change in their BMW handling. Indian bodies published additional guidelines with modified management and handling system.

The authors suggest that under crisis situation, practical guidelines with appropriate responsibility distribution can harmonize working system among HCFs, CBWTFs, and SPCBs/PCCs ensuring appropriate COVID-19 pandemic-related BMW and safe environment.

13. Conflict of Interest

The authors being from hospitals may be biased to favor HCFs'/HCWs' interest and readers are suggested to make their own opinion on authors' interpretation(s).

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