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A study on handling and management of biomedical wastes due to "Covid-19" & its impact on environment

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Abstract
Biomedical waste must be properly managed and disposed of to guard the environment, General public and workers, especially healthcare and sanitation workers who are in peril of exposure to biomedical waste as an risk. Biomedical waste include discarded blood samples, sharps, unwanted microbiological cultures, identifiable body parts other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies which will are in touch with blood and body fluids, and laboratory waste that exhibits the similar characteristics. Biomedical waste is distinct from normal trash or general waste. Medical facilities also generate hazardous chemicals and radioactive materials. While such wastes are normally not infectious; but they require proper disposal. Steps within the management of biomedical waste include generation, accumulation, handling, storage, treatment, transport and disposal.
The impact of biomedical waste on water, soil, air quality, the environment, and human health. Hospitals and nursing homes generate increasing amount of biomedical waste in an unscientific manner. As such, poor waste management practices by these institutions cause exposure to health hazards and actual environmental problems. Hospitals and nursing homes generate increasing amount of biomedical waste in an unscientific manner. As such, poor waste management practices by these institutions cause exposure to health hazards and actual environmental problems. This paper deals with the generation of biomedical waste due to Covid–19 and handling of this biomedical waste in Visakhapatnam city. The issue of biomedical waste identification, handling, and disposal must have a heightened review in order that better management practices and protocols can be established. The difficulty of biomedical waste identification, handling, and disposal has to have a heightened review so better management practices and protocols can be established. Disposal of this waste is additionally an environmental concern, as many medical wastes are classified as infectious and can potentially cause the spread of communicable disease.

Keywords: biomedical waste, Covid-19, collection, Segregation, transportation, disposal etc

Introduction

Biomedical waste is hazardous to the exposed population if not managed properly. Ten different categories of wastes have already been correlated with health risks. The numbers of hospitals and nursing homes are increasing with the expansion of the human population, and subsequently so too is that the generated waste. The standard of quality and quantity of waste produced on daily depends on the kind of specialization and also the standard of the hospitals. Furthermore, the hospital's location will likely determine the type and quantity of waste. Hospitals in metropolitan cities produce about over than 30 tons of biomedical waste each day. It's a matter of grave concern that almost all of the hospitals, especially government run hospitals, aren't maintained properly. Hospital employees often don't follow the rules and regulations developed in the 1998 hospital handling and management rules. However, the town of Gwalior is at a vital stage where there's an urgent have to create awareness about the hazardous impacts of waste on human health and also the environment. Medical waste is taken into account as a source of contamination of land and water sources if not rendered harmless before it's buried in land or disposed in water. The expansion of the medical sector round the world combined with a rise within the use of disposable medical products has contributed to the big amount of medical waste generated. Poor medical waste management causes environmental pollution, unpleasant smell, growth and multiplication of insects, rodents, and worms, and should result in transmission of diseases like typhoid, cholera, and hepatitis through injuries from sharps contaminated with blood (Babanyara *et al*. 2013). The target of this article is to review the impact of biomedical waste on different environmental parameters. India has come up with its own guidelines by the Central Pollution Control Board, India to confirm safe disposal of biomedical waste generated during treatment, diagnosis, and quarantine of patients with COVID-19. It's worth noting that India was one amongst the primary countries to require a proactive during this direction. The CPCB guidelines provide a series of steps for safe disposal of waste generated in isolation wards with COVID-19 patients, sample Collection Centers and Laboratories for COVID-19 suspected patients and quarantine camps/home-care facilities. The guidelines also outline the duties of Common Biomedical Waste Treatment Facilities, State Pollution Control Boards and Urban Local Bodies.

The key actions mandated for various stakeholders include:

- Separate colour coded bins/bags/containers in wards and maintaining proper segregation of waste as per Bio-Medical Waste Management Rules, 2016.
- Double-layered bags (using two bags) for collection of waste from COVID-19 isolation wards to confirm zero-leaks.

- Dedicated/marked collection bin and temporary cargo deck of biomedical waste before returning the identical to authorized staff at Common Bio-medical Waste Treatment Facility (CBWTF) for priority treatment and immediate disposal.
- Maintaining separate record of waste generated from COVID-19 isolation wards.
- Disinfection of inner and outer surface of containers/bins/trolleys used for storage of COVID-19 waste with 1 % Blanching agent daily.
- Reporting operation of COVID-19 ward and COVID ICU ward to SPCBs and respective CBWTF with in the area.
- Dedicated sanitation workers for biomedical waste so that COVID-19 waste is collected and transferred timely to temporary waste hold.
- General solid waste generated from quarantine centers to be handed over to waste collector identified by Urban Local Bodies (ULBs).
- Biomedical waste, if any, generated from quarantine centers/camps to be collected separately in yellow colored bags (suitable for biomedical waste collection) provided by ULBs.
- COVID-19 waste to be disposed-off immediately upon receipt by the Common Biomedical Waste Treatment Facility (CBWTF). The CBWTF may employ any of the permitted methods under the Bio-medical Waste Management Rules, 2016. These methods include incineration, Plasma Pyrolysis, Autoclaving/Hydroplaning, microwaving, chemical disinfection, among others.

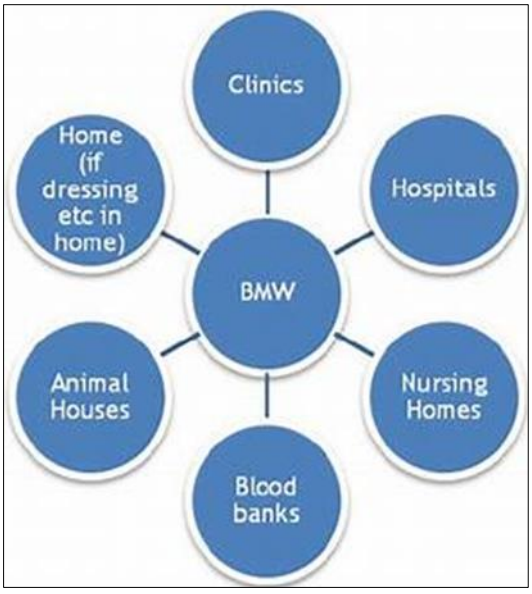


Fig 1

Review of Literature

Poor medical waste management causes environmental pollution, unpleasant smell, growth and multiplication of insects, rodents, and worms, and will cause transmission of diseases like typhoid, cholera, and hepatitis through injuries from sharps contaminated with blood (Babanyara *et al*. 2013). Most of the hospitals/nursing homes dispose waste in any open dumping site alongside city garbage (Ahmed 1997) [2]. The unaccepted truth behind such actions is that although the required technologies and equipment are available to confirm proper hospital waste management within the country, the unawareness among staff and native people regarding effective disposal techniques and policies hinders their implementation (Ul-Haque 2006).

The presence of appreciable quantity of heavy metals like Cd, Zn, Pb, and Cu, all of which can ultimately end-up within the soil and leached down the soil profile, may cause damage also (Huiying and Huaqing 2002). Eckelman and Sherman (2016) estimated the emissions from healthcare sector, and their potential harmful impact on public health. Over 10 years, the economic input–output model, from the National Health Expenditures (NHE), revealed negative public health comes. This sector is answerable for acid rain (12%), Greenhouse Gas (GHG) emissions (10%), smog formation (10%) criteria, air pollutants (9%), stratospheric ozone depletion (1%), and carcinogenic and non-carcinogenic air toxics (1–2%) everywhere the planet.

El-Salam (2010) investigated the hospital waste management practices from selected hospitals located in Damanhour City of El-Beheira Governorate and calculated the entire daily generation rate of their wastes together with physical and chemical properties of wastes. Rasheed *et al*. (2005) reported that hospital waste includes hazardous and nonhazardous waste. The chance of risk may arise due to infectious waste, sharps, chemical waste, pathological waste, genotoxic waste, pharmaceutical waste, radioactive waste, etc. Ngwuluka *et al*. (2009) assessed the waste management practices in hospitals and compared the same with international standards.

Aim and Objectives of Study

- To study the generation of biomedical waste due to Covid 19 in visakhapatnam city
- To analyse the process of waste management in city
- To study the impacts of biomedical waste on environment

Sources of Biomedical Waste

The main sources of biomedical waste are hospitals, medical clinics and laboratories. Because biomedical waste will be detrimental to human health, the law requires such facilities to follow procedures that protect the general public from coming into contact with it. Agencies that regulate different aspects of biomedical waste include Occupational Safety and Health Administration (OSHA), Food and Drug Administration (FDA) and Nuclear Regulatory Commission.

Categories of Biomedical Waste

- Biomedical wastes may be categorized as follows:
- Human Anatomical Waste: Human body parts, tissues and organs.
- Animal Waste: Animal body parts, carcasses, excreta, bleeding parts and wastes generated at veterinary hospitals.
- Microbiology and Biotechnology Waste: Wastes from laboratory cultures, live or attenuated vaccines, human and animal cell culture used in research, wastes from biological toxins.
- Waste Sharps: Needles, syringes, blades, scalpels.
- Discarded Medicines
- Soiled Waste: Cloth containing blood stains, blood coated cotton balls, soiled plasters.

- Solid Waste: Waste generated from disposable items like tubing and catheters.
- Liquid Waste: Waste generated from laboratory housekeeping activities.
- Incineration Waste: Ash generated from incineration of biomedical waste.
- Chemical Waste: Chemicals used for disinfection.

Fig 2

Case Study (Visakhapatnam City)

Visakhapatnam is a very fast growing city heading towards metro status and is additionally enlisted by PM of India as a smart city. Visakhapatnam's urbanization process has been alarmingly fast making it a challenge for authorities to produce the much needed infrastructure. Of the various challenges that Visakhapatnam face, biomedical waste management is one amongst the critical issues. Biomedical waste management has recently emerged as an issue of major concern not only to hospitals, nursing home authorities but also to the environment. The entire practice of bio medical waste management was being carried out unsupervised. Lack of proper monitoring and regulation, hazardous bio medical waste are mixed with non-hazardous waste, making the entire waste hazardous.

Such hazardous wastes because of inappropriate disposal/ treatment strategies are potentially infectious and present a potential hazard to public health and the environment. Effective and efficient waste segregation systems should be developed and implemented. Information with respect to risks involved in biomedical waste management practices have to be disseminated for public and general community. The rise in Covid-19 cases in Visakhapatnam has also led to a rise in the amount of biomedical waste produced in the district every day. A dedicated group has been entrusted the responsibility of collecting this waste from Covid-19 centers and shifting it to a biomedical treatment plant at Achyuthapuram. According to a senior health official, PPE kits, masks and gloves as well as other things used to treat Covid-19 patients can be used only once and have to be discarded. This has led to an increase in production of biomedical waste. "Further, they are also treating food packets used by patients and health officials at Covid-19 centers as bio-waste. At the moment, the 33 Covid-19 centers in the district are producing no less than 400kg biomedical waste per day," Those who collect and dispose this waste first pack it in double-layered covers. Then, the packets are disinfected and put in a container. The container is then shifted to the treatment plant where it is treated at 800°C. There is a big network of Health Care Institutions in India. The hospital waste like body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster casts from infected and contaminated areas are very essential to be properly collected, segregated, stored, transported, treated and disposed of in safe manner to prevent hospital acquired infection.

The information was collected from 33 centres of Covid 19 Hospitals Including private and Government Hospitals in Visakhapatnam City, Andhra Pradesh, India.

The following images shows that the different biomedical wastes

Fig 3: Waste PPE like gloves, masks etc

Fig 4: Waste of syringes, blood cottons etc

Generation of Medical waste through hospitality Waste due to Covid-19 and its management

1. Personal Protection Equipment (PPE)

Clear guidelines for healthcare professional's protection are available at OSHA control and prevention. Additionally, the CDC advises that administrative rules and engineering controls, environmental hygiene, correct work practices, and appropriate use of PPE are all necessary to prevent infections.

2. Disinfecting Agents

Corona viruses are enveloped viruses, meaning they're easily disinfected with the employment of appropriate disinfectant products per the US Environmental Protection Agency (EPA). For cleaning and decontamination information, consult CDC guidance for cleaning and disinfecting environments, including those contaminated with other corona virus.

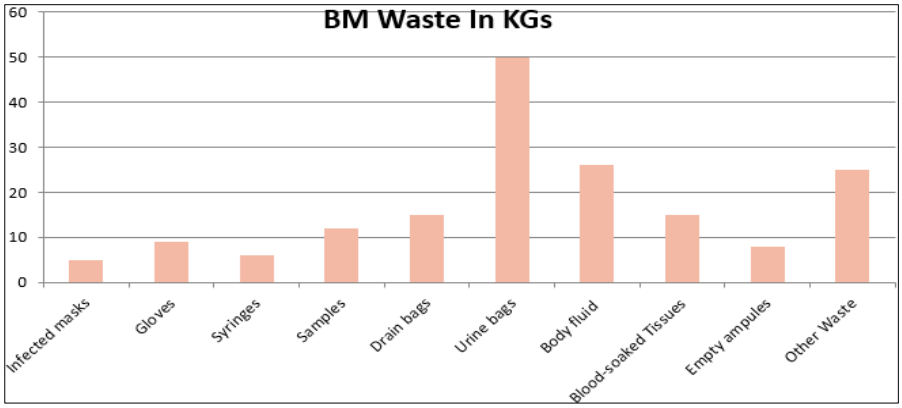
3. Trauma Scene Waste Practitioners
Trauma scene waste practitioners who are registered with the MWMP should follow their disinfecting procedures as established. Wear appropriate PPE, follow the OSHA Blood borne Pathogens standard, and use the technologies and chemicals appropriate to the task for cleanup and disinfection.

4. Packaging COVID-19 Contaminated Waste
Waste from COVID-19 patients is handled as standard RMW. Talk over the MWMA for the statutes in California. The CDC has provided general, not COVID-19 specific, recommendations within the Guidelines for Environmental Infection Control in Health-Care Facilities (2003). CDC guidance states that the management of RMW should be performed in accordance with routine procedures because it has not been implicated within the transmission of Severe Acute Respiratory Syndrome Corona viruses (SARS-CoV) including COVID-19.

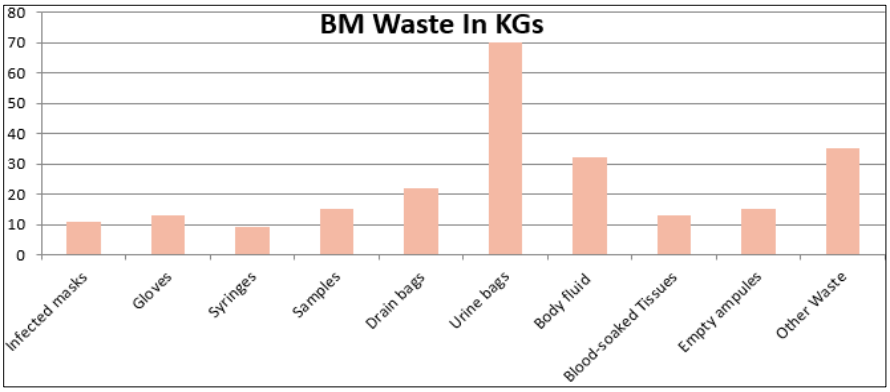
5. Transportation within a Facility and Offsite
Facility operation and logistics vary among health care facility types requiring each facility to develop a Medical Waste Management Plan (Plan) tailored to handle the needs at each facility while maintaining compliance with the MWMA. Each Plan should include the procedures of transporting waste from the area it's generated in to the interim storage room and ultimately to the Designated Accumulation Area. From this area, the waste will then be treated onsite or prepped for transportation offsite for treatment.

All containers for offsite transport should be USDOT approved. Pharmaceutical waste shall even be transported in compliance with the United States Drug Enforcement Administration (DEA) requirements.

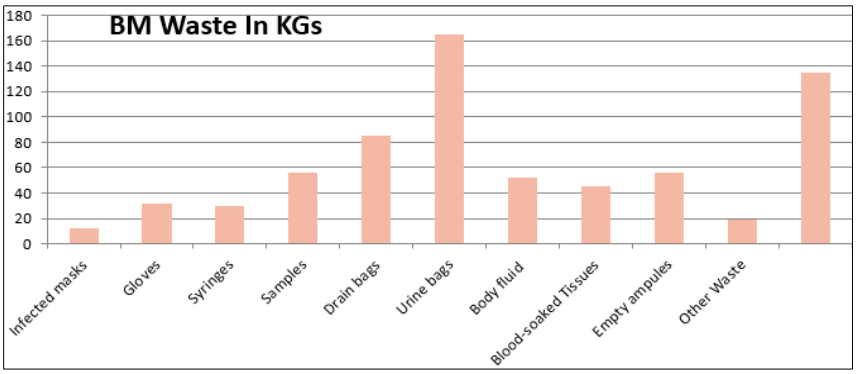
RMW and Category B infectious substances are listed within the USDOT Hazardous Materials Regulations (HMR) 49 Code of Federal Regulations 173.197.



Graphs 1: Shows the generation of different biomedical waste in KGS/ month from KGH hospital



Graphs 2: Shows the generation of different biomedical waste in KGS / month from government hospital (10)



Graph 3: Shows the generation of different biomedical waste in KGS / month from private hospital (22)

Handing of Covid-19 Biomedical Waste

In India, in line with the Indian Council of Medical Research (ICMR), a complete of 20,864 samples from 19,974 individuals has been tested for the corona virus as of March 24, 2020. So far, a complete of 482 individuals in India has been confirmed positive and nine deaths are recorded, as of March 24, 2020. Though India already had Bio-Medical Waste Management Rules, 2016, the CPCB guidelines were released to make sure that the waste generated specifically during testing of individuals and treatment of COVID-19 patients is disposed of in very scientific manner. Biomedical waste, per the prevailing biomedical waste rules, is any waste that's generated during the diagnosis, treatment or immunization of Kith and Kin, animals or research activities etc. It could include human tissues, items contaminated with blood or body fluid like dressings, plaster casts, cotton swabs, beddings contaminated with blood or body fluid, blood bags, needles, syringes or any other contaminated sharp object.

For isolation wards where COVID-19 patients are kept, the rules stressed that, additionally to rules regarding biomedical waste, as a precaution, double-layered bags (two bags) "should be used for the gathering of waste to confirm adequate strength and no-leaks." "Collect and store biomedical waste separately before delivering identical (to) Common Bio-medical Waste Treatment Facility (CBWTF). Use an avid collection bin labeled as COVID-19 to store COVID-19 waste and keep separately in an exceedingly temporary area before turning in to the authorized staff of the CBWTF. Biomedical waste collected in such isolation wards also can be lifted directly from ward into CBWTF collection van," said the rules while seeking a separate record of Waste generated from COVID-19 isolation wards. The guidelines also sought that bags/containers used for collecting biomedical waste from COVID-19 wards should be labelled as COVID-19 waste to enable CBWTFs to spot the waste easily for priority treatment and immediate disposal after getting it. Additionally, the rules sent to all or any states, direct use of dedicated trolleys and collection bins in COVID-19 isolation wards and recommended that the surface of containers, bins, trolleys used for storage of COVID-19 are disinfected regularly.

The number of persons infected with the corona virus disease (COVID-19) is continuously rising throughout the globe. In these circumstances, waste management, including of hazardous, medical, and household waste is of utmost importance. During the viral outbreak, many varieties of additional medical and unsafe waste are generated including infected masks, gloves, syringes, samples, and other protective equipment, drain bags, urine bags, body substance or blood-soaked tissues/cotton, empty ampules etc. Medical waste and household waste, when mixed, can create secondary impact upon the health of the community at large and therefore the environment. Unsound management of this waste could cause unforeseen "knock-on" effects on human health and therefore the environment and so, safe-handling and disposal of such waste is crucial.

Process of Biomedical Waste Disposal in Visakhapatnam city

1. Waste collection
2. Segregation
3. Transportation and storage
4. Treatment & Disposal

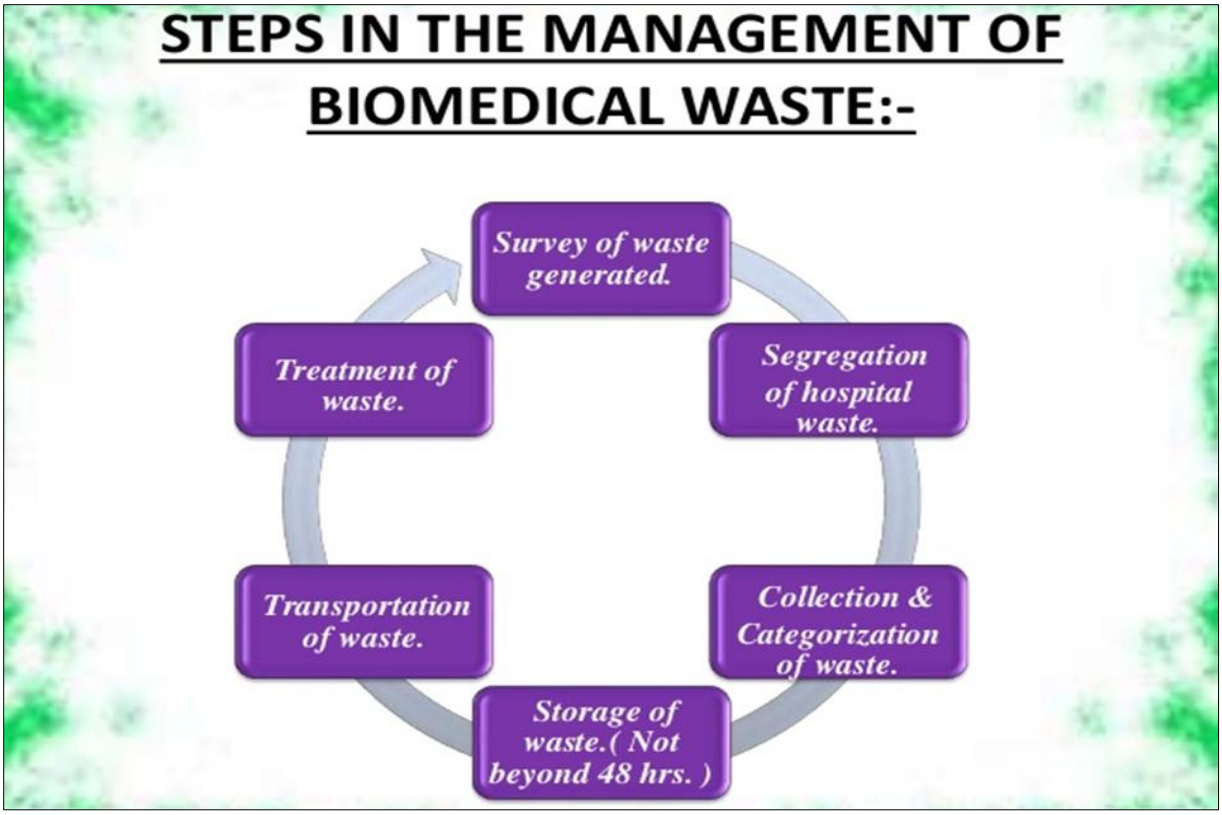


Fig 5: Shows the process and management of biomedical waste

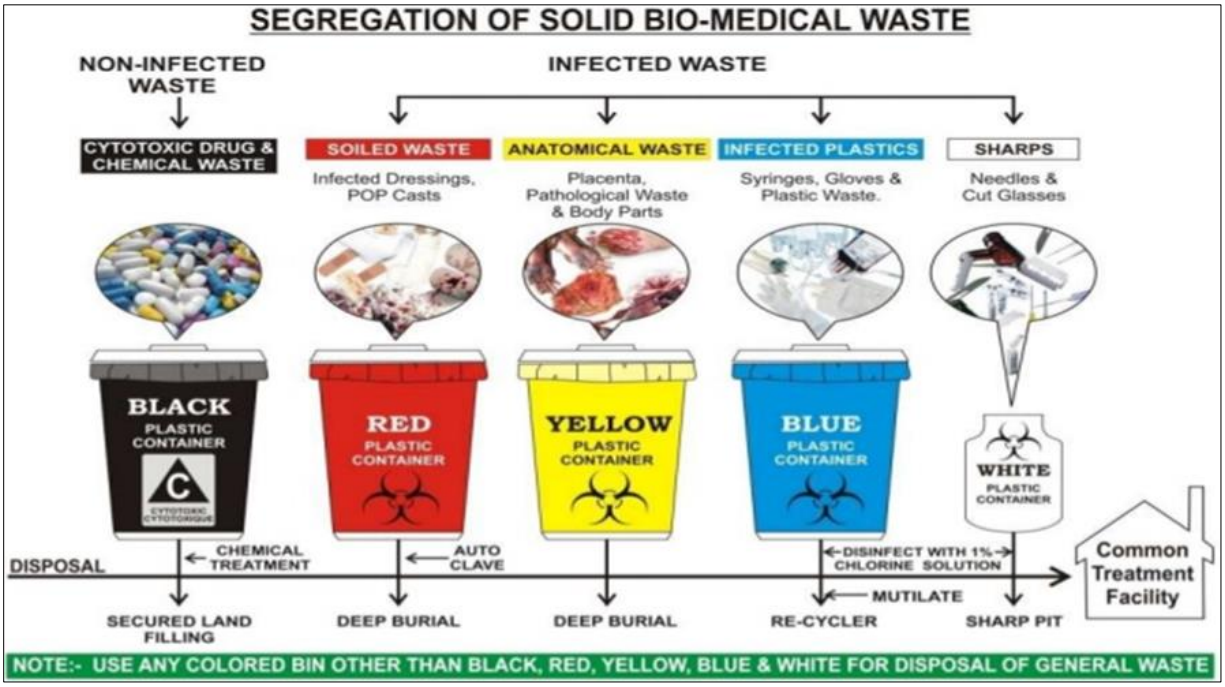


Fig 6: Shows the segregation of Bio medical waste due to Covid 19

Effects of Biomedical Waste

Effects on human health

- Gastroenteric infections
- Respiratory infections
- Herpesvirus
- Genital infections
- Streptococcus spp.,
- Anthrax
- Meningitis
- Human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS)
- Haemorrhagic fevers
- Septicaemia
- Bacteraemia
- Candida albicans
- Viral hepatitis A virus
- Viral hepatitis B and C viruses

Effects on Environment

1. Impact on air pollution

Burning of biomedical waste may pollute the environment and will mix different pollutants to a level that may be dangerous to human health. Karthikeyan, Balasubramanian, and Iouri (2006) argued that greenhouse gas and particulate emissions are considered as a challenging issue from municipal solid waste dumping sites. The burning of hospital waste at these sites is a serious threat for the environment and human health. It releases harmful pollutants that cause various types of respiratory problems among the residents. Their study revealed that dust, black carbon, ammonia, sulfate, and nitrate are the major species of PM 10 and PM 2.5. The particulates were found to be high during the summer than the monsoon. The significant variation among the samples were observed and ranged from 211 to 900 $\mu g/m^3$, and exceeded the upper limits of 150 $\mu g/m^3$ standards prescribed by Central Pollution Control Board (CPCB).

2. Ground water contamination

The improper disposal of biomedical waste may cause negative impact on the water quality as different pollutants may leach out from the waste dumping sites into the ground water. Al Raisi *et al*. (2014) [4] assessed and found that heavy metals in leachate were exceeding the drinking water standards. The concentrations of Al, V, Cr, Mn, Co, Ni, Ba, Pb, and Fe 2.030, 0.8855, 2.795, 0.623,0.138, 0.669, 0.7984, 0.145, and 39.25 mg/L, respectively. The effect of these contaminants was considered as a surface and ground water contamination. The analysis of BMW ash showed increased hardness (1320 mg/L) and chloride (8500 mg/L) content in leachate which is above the permissible limits set by World Health Organization (WHO) and Environment Protection Agency (EPA) guidelines for drinking water. Gautam, Pathak, and Sahni (2006) assessed the ground water quality of Sewapura MSW dumpsite near Jaipur. The high amount of fluoride (2.4–3.2 mg/L), chlorides (288.4–1038.2 mg/L), and TDS (610.4–1828.4 mg/L) were found in the studied samples which are of higher range of acceptable limits. The ground water is polluted by percolation of toxic substances from MSW and hence, it must be prohibited by the concerned authorities.

3. Impact on Soil Quality

Improper and unscientific disposal of biomedical waste may change the quality of soil near waste dumping sites. Different pollutants may get mixed with the soil and may change the chemistry and biology of the soil ecosystem. Abidemi and Theresa (2015) analyzed five heavy metals (chromium, nickel, zinc, lead, and copper) for their levels in soil. The concentration of heavy metals in soil were zinc (1142 ± 867 mg/kg), nickel (25.3 ± 50.12 mg/kg), copper (120 ± 80 mg/kg), lead (127 ± 57 mg/kg), and chromium (3.47 ± 2.36 mg/kg). The level of heavy metals at different sampling site were higher than soils from background with factors of 67 (zinc), 18 (copper), and 20 (lead).

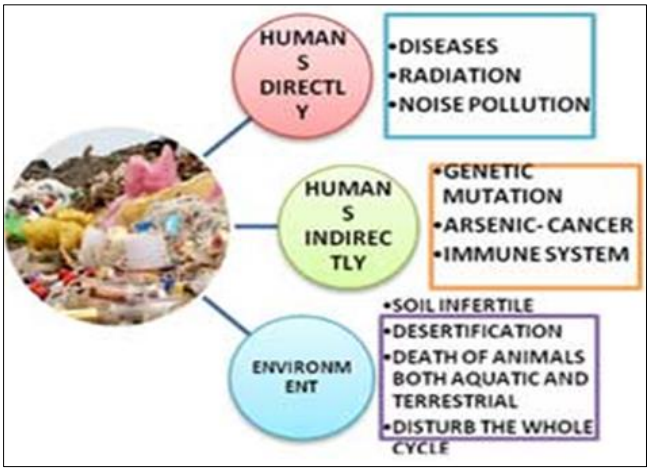


Fig 7

Treatment Methods

- Incineration
- Autoclaving
- Gas sterilization
- Chemical disinfection
- Microwave
- Irradiation
- Thermal inactivation

Treatment of COVID-19 Waste

RMWs are treated or decontaminated to reduce the microbial load in the waste and to render the by- products safe for further handling and disposal. Treatment processes are permitted under each state's medical waste statutes and regulations and treatment methods may include autoclaving, incineration, chemical disinfection, grinding/ shredding/disinfection methods, and energy-based technologies (e.g., microwave or radiowave treatments). Waste treated in California shall follow the requirements outlined in the MWMA Sections 118215 – 118245. If onsite treatment is not available or the health care facility chooses to not treat the waste onsite, the facility should package the waste appropriately for transport offsite (see Transportation section above) to a permitted medical waste transfer station and/or treatment facility. Waste shall be taken to a permitted Transfer Station and Offsite Treatment facility (TSOST) for treatment.

A list of permitted TSOST facilities in California can be found on the Medical Waste Management Program website. If the waste is being sent out of the State of California for treatment, check with the receiving State for their requirements on the treatment of medical waste and specifically medical waste contaminated with COVID-19.

Once the waste has been efficaciously treated by a permitted medical waste facility, the waste is no longer considered RMW and can be managed as solid waste. Treatment facilities shall coordinate with the solid waste landfill for final disposal of the waste. Direct efficacy questions for medical waste treatment to your Local Enforcement Agency and/or to the CDPH, Medical Waste Management Program.

Fig 8

Conclusions and Recommendations

The Bio-medical waste generated from the hospitals and other source should be treated. Incineration of Bio-medical waste is one of the techno-economical viable scheme, which have many advantages such as significant volume reduction, weight reduction and also ability to manage most types of wastes with little processing before treatment.

Biomedical waste can be managed properly by ensuring proper segregation at the source, the use of accurate packaging (leak resistant, puncture resistant and not susceptible to degradation by cleaning agents in case the packaging is reused), appropriate color coding, proper in-house movement of waste (minimizing employee exposure to biomedical waste in a workplace), designating waste storage areas and ensuring safe disposal.

The quantities and proportions of different constituents of wastes, their handling, treatment, and disposal methods in different healthcare settings varies and treatment and disposal methods have been found to be inadequate in most of the studies. Hazards associated with poor biomedical waste management and shortcomings in the existing system have been identified by various researchers.

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