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COVID 19 BIOMEDICAL WASTE TREATMENTS: A REVIEW, CURRENT DEVELOPMENTS, FUTURE POSSIBILITIES

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Abstract: The current situation of the COVID-19 pandemic has led to a sudden increase in Biowaste. Biowaste management is a major challenge in cases where we require very careful handling, incineration, and disposal of infectious waste obtained from multiple hospitals. The products' usage and disposal are highly difficult due to the chance of infection very abruptly. The current requirement is an innovation in this field of biowaste management. For humanity to survive this pandemic with an appropriate disposal method of Biowaste from the hospitals without causing harm to the environment and risking the humans is the current necessity. It is a compulsion for an urgent innovation, which will require everyone's cooperation. From cotton swabs, blood sample tubes, masks, PPE kits, etc., their disposal had become challenging and very harmful for the humans in charge of their appropriate dumping and waste management. This review will cover the current developments in biowaste management technologies and the possible future and modifications in the process.

Keywords: Biowaste Management, COVID-19, Waste Disposal

I. INTRODUCTION

COVID-19 has been a game-changer for multiple industries like samt1zers, cleaning equipment, etc., but had its immense side effects on the other side. The hospitals were filled, and patients with mild symptoms started becoming impatient, leading to a crowd filled with patients. COVID-19 patients require very intensive care, and at the initial stages, there were very heavy risks involved when the pandemic was on its rise in the first quarter of 2020. The number of patients who tested positive with the virus shot up, and the intensive care demands a lot of medicines and products to be used. The waste generated from just one patient within 10 days of hospital quarantine has a lot of waste left behind, which may be contaminated from cotton swabs, blood/urine sample test tubes, and the human excretion waste collected while the patient is bed-ridden in an intensive care unit. These all contribute to the Biowaste that comes out of the hospital, not just for one, for hundreds of patients in just one hospital. Biowaste is generally harmful to the person in contact, but in the case of COVID- 19, the situations are intense. The virus is highly contagious, and dumping this waste obtained into the ground directly may not be a solution. Incineration is a solution, but it has its side effects on the environment.

And in some cases, there are chemical treatments required, which may cause a lot of environmental harm. The sudden economic decline worldwide has impacted the current Technologies, which may be very costly, and the innovations we require are quite extensive and urgent. Currently, many consultancies and many organizations are working over the biowaste management aspect for Covid-19 and also many e research works going on in multiple scientific Laboratories, and still, they are many research works under patent process. This paper will be reviewing the current scenario, and the developments which have taken is to date.

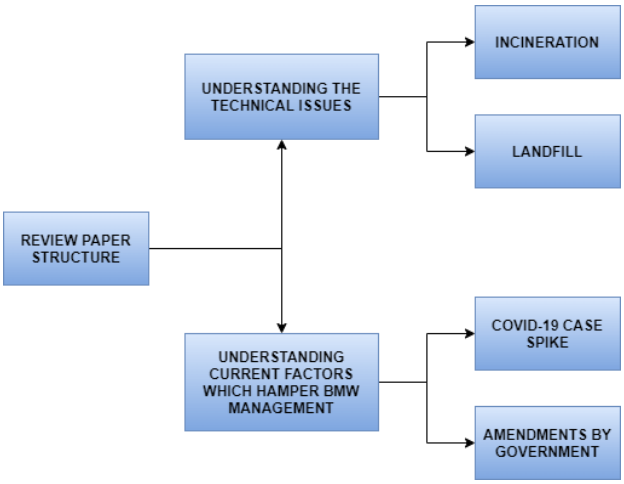

Figure 1. The Structure of the Review Paper.

II. UNDERSTANDING THE LITERATURE

Current Issues and Methods of disposal

Source separation is recommended based on the segregation of infectious and non• infectious wastes from hospitals in non-epidemic periods. And the COVID-19 Biowaste is

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mostly segregated in a Yellow marked bag, which is kept separate from the other wastes since it will require an extra treatment before disposal in some cases. (Table 1.)

Table 1. Colour Codes for disposal bags and Waste Segregation with their disposal procedure.

Colour codes	Types of Waste & their Respective Treatments
White	Surgical instruments and sharp metallic wastages like needles scalpels syringe with the needle should contain a leak-proof box, or a container should have a white marking. Autoclaving and shredding should be done. After this encapsulation process should be followed or should be disposed of in iron foundries.
Blue	The glassware used in hospitals it can be intact or broken. The medicine, ampules except those contaminated with cytotoxic wastage, etc., should contain a leak-proof box, or a container should have a blue marking. This type of waste never requires any pretreatment but shredding autoclaving, followed by recycling, should be the procedure for the disposal full stop since this glass waste is reusable. In some cases it can be disinfected or sterilized and then utilized.
Yellow	Case 1: the solid waste obtained from hospitals containing blood contamination or body fluids like cotton swabs, etc It requires no pretreatment but doing final disposal incineration is one option available. Case 2: the pathology lab waste and distance accident or any cleaning for housekeeping wastages, etc. This type of waste may require sterilization and a different collection system to keep the waste ideas separate. Case 3: Face masks, PPE kits, caps, etc. Pretreatment is not required during final disposal incineration is an option. Case 4: linen clothes for patients, specimens, vaccines, blood bags, Pathology laboratory waste, cultural stock, etc. Free treatment with non-chlorinated chemicals is highly required. This free treatment is followed by the incineration procedure.
Red	Case 1: Surgical gloves which are used for contaminated with blood or human body fluids. Case 2: tubing bottle set test tube nasal cannula urine bags glucose bottles, etc. There is no specific treatment required, but this type of waste should be autoclaved should be added, and then should be recycled

Incineration is a process in which the combustion of waste takes place. The waste obtained from the hospital is, in most cases, treated using non-chlorinated processes. These wastages are converted into ashes for appropriate disposal. But there should be appropriate differentiation and segregation between the types of wastes which should be disposed of and not cause harmful side effects like the spreading of diseases. Landfills are also an option, but still, this area requires research work if it may contaminate the soil.

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Because in general cases, the landfills can not have any construction over it, for a few years ranging from 7 to 11 years, but if the COVID-19 virus has a contaminating effect, it will require major pretreatment procedures.

Current factors which may impact Biomedical Waste Management.

The current situation has been worsening. There has been a change in the number of patients who are getting infected with the covid-19 virus. In India, Maharashtra has taken the lead in several most cases obtained to date. And in early 2021, there was a decrease in numbers in all the states, but Maharashtra, Tamil Nadu, Karnataka have been experiencing an immense increase in the number of patients getting infected. This is one of the major causes of uncertainty in the biowaste management area, where the wastage per patient or in technical terms per capita is 1.2 kg as per the WHO survey conductor in 2020. (Figure 2)

An increasing number of patients eventually increases the outcome of Biowaste from the hospitals, and the management is also very difficult. From incineration to landfill, both have the highest demand currently, but the available land is scarce, and the incineration procedure is only efficient for burning some equipment which ranges from plastic papers and a cotton swab. There has been multiple research work done on the supply chain of biowaste management during covid-19 to aver the spread of the virus. There have been multiple revisions regarding the guidelines for managing waste generated during the Diagnostics and treatment of covid-19 for the suspected patients. There were multiple guidelines issued, and for collecting and storing bio-waste, the foot-operated Bin labeled as covid-19 was separated from other patients and disposed of separately. 1% sodium hypochlorite was used as a disinfectant for the covid obtained from the patient. There were multiple safety standards according to ISI, BIS, ISO installation in NABL/NABH accredited hospitals, as follows:

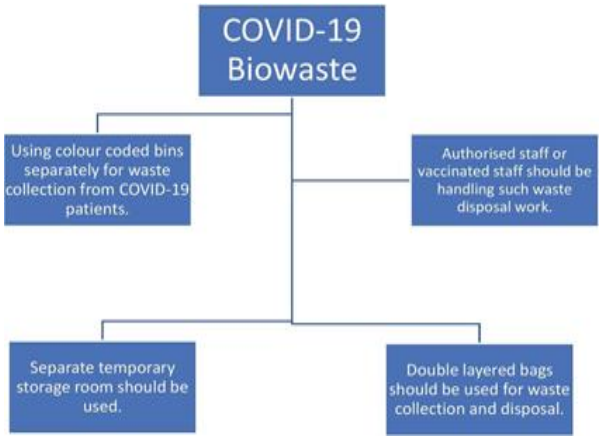

Figure 2. Biowaste Management Process Prerequisites for COVID-19.

Validation test:

- Chemical control

- Browne's tubes
- Bowie Dicktest: each batch,>1sr-Microbiological control-spore test
- B. stearothermophilusl w (autoclave lxl 06)
- B. atropheus lxl 04 (Microwave)

-Physical control includes temperature & pressure record

III. RESULTS & DISCUSSIONS

In India, the central pollution control board mentioned the 28 states with only 200 authorized BMW treatment and disposal facilities. With the utmost effort while complete with the covid-19, there was a sudden spike in the amount of waste generated which was a great challenge. Still, compared to other countries, India had 1.2 kg per capita of biomedical waste compared to other countries where France had 2.5 kg per capita. USA had 4.48 kg per capita of Biomedical Waste according to the survey done by CPCB. In Kerala, when there was a sudden spike in covid-19 case numbers, an increase of 13 tons was reported within a week in May 2020. Maharashtra is the most disturbed and hampered with the effect of the covid-19 situation. The health care facilities reported 50 tons of Biomedical Waste increased per day. Covid-19 related Biomedical Waste is mostly the yellow category waste, which usually includes linen, Pharmaceutical and cytotoxic waste, and biotechnological waste, which is usually obtained from pathology Labs, including blood sample and urine sample bottle and Anatomical waste, Placenta, etc. The use of polypropylene rose by 10% (M Goswami et al., 2020)

Table 2. The Key Findings from the Current Research Works.

Author and Paper Title	Outcomes and key findings
Sharma et al., 2020 Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic	Virus contaminated waste and the staff's approach to clean and manage such Biowaste. The main focus this paper drew was over the food wastages and plastics. This paper was a mere comparison of the research literature.

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Ramtekeand Sahu, 2020 Novel coronavirus disease 2019 (COVID-19) pandemic: considerations for the biomedical waste sector in India	Disease transmission was the main point of this paper around which the paper was focusing on the other aspects of biowaste management techniques.
Das et al., 2020 Biomedical Waste Management: The Challenge amidst COVID-19 Pandemic	Indiscriminate biomedical waste disposal was briefly discussed and
Jain, S., et al., 2020 Strategy for repurposing of disposed PPE kits by production of biofuel: Pressing Priority amidst COVID-19 pandemic.	This paper discusses the facts for the disposal of PPE kits in an innovative manner to generate biofuel. The process of pyrolysis of P.P. by altering the parameters To optimize the liquid oil yield.
Kumar et al., 2020 COVID-19 creating another problem? Sustainable solution for PPE disposal through LCA approach	It is a detailed study of PPE kits and their effect on the environment. Landfill and incineration methods are compared for the disposal method for PPE kits that are used.

V. Thakur, 2020, has worked over PESTEL (Political, Economical, Social, Technological, Environmental, Legal) dimensions and applied fuzzy logic to understand the situation of COVID-19. Hierarchical and non-hierarchical dimensions were also checked for sustainable development during covid-19 and their interactions among PESTEL. This consists of 17 dimensions that may affect the decision-making of handling healthcare waste or the biomedical waste of covid-19 the TISM methodology to develop relationships among PESTEL.

MS Haque et al., 2020, had analyzed multiple cities like the Hubei province of China, which reported nearly 240 tons per day of Biomedical Waste which was recorded and in main la the capital of Philippines reported 280 tons and in Jakarta, 212 tons per day of Biomedical wastage was reported during the covid-19 pandemic the pandemic had postulated the human being to use P.P. kits, face mask, and hand gloves, which majorly comprise to the single-use plastic waste and it cannot be necessarily not causing harm in all the cases.

IV. SUMMARY & CONCLUSIONS

The biowaste management with a sudden increase in the number of covid patients and the contagious effects that may also lead to the spreading of the COVID-19 virus requires a lot of attention. Various aspects can be worked over to resolve the biowaste management for COVID-19 without having the humans be close to any contagious biowastes.

The economic situation has been worsening for the whole country. The economic crisis demands and innovation in which we can develop low-cost Technologies for low-cost implementations for multiple procedures incineration process is one way to create an innovation like Biowaste management from covid-19 patients may include multiple plastic wastes that release high energy burning in comparison to cotton or paper. Energy can be utilized from the combustion of these biowastes to generate electricity. There is a demand for research in sustainable development, and this can be one of the major examples or one of the major patents for research work potentially to enhance the quality of life. Another aspect of biowaste management may include a modification in the supply chain and management of the Biowaste. The supply chain has to be so that there is less contact between the volunteers and the Biowaste. The hospitals may use multiple modifications and dustbin which can also be Incorporated with the conveyor belt mechanism at one junction point after collecting all the dustbin and can be filled in a truck at one junction and then the segregated waste reach the destinations where ever they belong for example the plastic paper waste will undergo incineration and the access will be filled in the landfill or some cases biowaste may be treated using non-chlorinating processes and then incinerated. Dam metal and Shark waste like surgical instruments, namely scalpels and some syringes with needles, can be directly sent to the iron foundry where these can be disinfected and melted to be reused as a metallic component, which may encourage recycling processes instead of destroying the metal. The glass waste obtained can also be disinfected and sterilized.

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