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REVIREW ARTICLE

Biomedical waste management and public health risks during COVID-19: Scenario of COVID diagnosis laboratories

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ABSTRACT

The unprecedented outbreak of COVID-19 has significantly increased the volume of biomedical waste while the number of waste management workers halved in the state of lockdown in Bangladesh. The improper management of biomedical waste might facilitate the spreading of COVID-19 as SARS-COV-2 could survive on these wastes for variable durations. In this article, we presented the impact of COVID-19 on biomedical waste generation and management in Bangladesh and the waste disposal practices in laboratories. We also presented the practice of waste management in two COVID testing laboratories in Bangladesh. About 109 laboratories are working on the detection of COVID-19 through Real-time Reverse Transcriptase PCR. In April 2020, at least 14,500 tons of medical wastes were produced throughout the country which was almost double the amount produced previously (7756.3 tons per month earlier). COVID testing laboratories used biohazard bags for disposing of wastes and autoclaved these waste-filled bags before releasing them from the laboratory. These bagged wastes are collected by the City Corporation (local city authority) workers for final disposal. However, proper management of excess volumes of biomedical waste requires multidisciplinary collaboration of different stakeholders including the government, hospital administration, laboratory workers, researchers, and policymakers.

Key words: healthcare waste, COVID diagnostic laboratory, medical waste management, novel coronavirus, environmental pollution, health hazards

INTRODUCTION

A pneumonia-like disease outbreak caused by an unknown coronavirus in December 2019, has been identified by the World Health Organization (WHO) as the Novel Coronavirus Disease 2019 (COVID-19). It is an enveloped, positive-sense, and single-stranded RNA virus, and has been named SARS-COV-2 (Severe acute respiratory syndrome coronavirus-2).[1] Soon after the pneumonia disease outbreak in Wuhan city, China, the transmission of COVID-19 was found to be through human to human respiratory contact. COVID-19 wreaked havoc and was subsequently

declared a pandemic. On 7th March 2020, the first three COVID-19 cases were detected in Bangladesh,[2] which led the Bangladesh government to dedicate many public and private hospitals and laboratories for diagnostic and treatment purposes. As a result, this pandemic has caused a spike in the volume of biomedical waste production. Medical waste is generated during the diagnosis, testing, treatment, research, and production of biological products for humans or animals.[3] Not all biomedical wastes are hazardous, and the majority belong to non-hazardous or general waste. In Dhaka, the capital city of Bangladesh, 18% of healthcare waste is hazardous [4]. Hazardous waste can be categorized into a few major groups- Infectious, clinical, radioactive, and sharp waste. SARS-COV-2 can survive on waste materials for up to 72 hours on plastics, 48 hours on stainless steel, 24 hours on cardboard, and 4 hours on copper.[4] Thus biomedical wastes could facilitate the transmission of virus. Therefore, the strict management of biomedical waste is crucial in this time of pandemic to prevent the spread of the virus and protect the forntline workers.

METHODOLOGY

We prepared this manuscript by reviewing the available literature and data. Information was gathered by searching the key terms "Bangladesh", "Biomedical waste", "COVID-19", "COVID testing laboratory", "Healthcare waste", and "Waste management". We studied reports from various local institutions and ministerial websites like the Directorate General of Health Services (DGHS), Institute of Epidemiology Disease Control and Research (IEDCR), Ministry of Health and Family Welfare Bangladesh. Information from different international organizational websites such as the World Health Organization, Center for Disease Control and Prevention (CDC), United Nations Environment Programme (UNEP) were incorporated into our study. Data from different local and international news portals and magazines were also included. Furthermore, we cited similar scientific articles published from different countries to justify our study. The inclusion criteria were timely articles related to biomedical/healthcare waste production and management in Bangladesh as well as the rest of the world. In addition, articles regarding the challenges posed by COVID-19, human and environment health risk of medical waste, practices of waste management in COVID testing laboratories in Bangladesh also included. We excluded data and articles reported solely on household waste. A total of 24 articles were reviewed which have been shown in the table below.

Table 1 Different source of resources used in the paper

Category	Number	Source
Bangladesh government organizations	03	Directorate general of health services Ministry of health and family welfare Institute of epidemiology, disease control and research
International organizations	03	World health organization United nations environment programme Center for disease control and prevention
News agencies	05	Dhaka tribune The business standard ACR plus Celitron Anadolu agency
Research articles	07	Biosafety in Microbiological and Biomedical Laboratories. Impact of COVID-19 pandemic on waste management Environmentally Sustainable Management of Used Personal Protective Equipment Novel coronavirus disease 2019 (COVID-19) pandemic: considerations for the biomedical waste sector in India. Environmental perspective of COVID-19 Biomedical waste management for health care industry. Healthcare Waste Management Practices in Bangladesh: A Case Study in Dhaka City, Bangladesh

Increased production of Biomedical waste in pandemic

There are an estiamted 610 government hospitals, 5,321 registered private hospitals, and clinics, with a total of 146,197 beds in Bangladesh. Moreover, 9,529 registered diagnostic centers are operating in the country.[5,6] These health care facilities release a massive amount of biomedical waste, without proper disposal or management. In pre-COVID era, medical waste generation rate was estimated as 0.8 to 1.67 kg/bed/day in Bangladesh. A study in 2016 found that the average medical waste generation rate was 2.6 kg/bed/day in capital Dhaka.[7] The medical college hospitals produced an average of 1.54 kg/bed/day waste, specialized hospitals produced a total of 1.62 kg/bed/day and the district hospitals together generated 1.645 kg/bed/day waste.[8] Throughout the country, medical waste generation rate was 7756.3 tons per month and 1110 tons of these were generated in Dhaka .[9]

In this COVID-19 crisis, health care providers including doctors, nurses, and laboratory technologists have been advised to use personal protective equipment, gloves, masks, face shields, and goggles, which cause the overflow of medical waste carrying the virus. According to the WHO's standard, PPEs (Personal Protective Equipment) are one-time use, and every set of PPE becomes hazardous after being used for a single time.[10] Besides PPE, there are other types of hazardous wastes like facial tissue, gauze pieces, oxygen masks, test tubes, nasopharyngeal swabs, saline bags, disposable syringes, and needles generated from use on infected patients. Moreover, hair covers, hand gloves, and face masks used by citizens are regularly found in the

municipality bins mixed with household waste. In March, the first month of the COVID-19 outbreak in the country, 4,500 tons of excess hospital wastes were added in addition to the average amount.[11] The Environment and Social Development Organization (ESDO) estimated that in April 2020, at least 14,500 tons of hazardous waste, including used gloves, masks, hand sanitizer containers, and plastic bags have been generated all over Bangladesh. Dhaka alone generated 3076 tons of waste in April, including 1,916 tons from gloves, 447 tones from surgical masks, 270 tons from sanitizer containers and 443 tons from polyethylene shopping bags.[12] The amount was 6186 tones in Dhaka in July 2020 [13] In India, an estimated 2.5 to 4 kg/bed/day of biomedical waste was produced instead of the average of 0.5 kg per bed everyday before the pandemic. 28% was disposed of without proper treatment or following the proper protocols.[14] China also recorded six times more medical waste generated in Wuhan city than the usual volume.[15] In Barcelona, Spain the amount of biomedical waste increased from 275 tons to 1,200 tons due to the pandemic [16]. The United Nations Environment Programme (UNEP) reported that the average increase of healthcare waste due to COVID-19 is 3.4 kg/person/day and 2.5 kg/bed/day in developing countries.[4]

Environment and Human Health Risks

Hospitals have to store their waste in separate bins: general/non-hazardous waste in black, infectious, pathological, and anatomical waste in yellow, sharps waste in red bin, radioactive waste in the silver bin, recyclable waste in the green bin, and liquid waste in the blue bin. Medical waste requires proper treatment or decontamination before disposal. Various treatment and disposal methods involve incineration, chemical disinfection, steam-sterilization (autoclaving), microwave irradiation, and land disposal using sanitary landfills.[17] Emergency response healthcare waste Need to treat with nonburnable technologies like autoclave and incineration [4]. Incineration is the final step after autoclaving to burn these waste completely following the EPA (U.S. Environmental Protection Agency) standards.[18,19] In incineration plants, a temperature near 1000-degree Celsius is required to confirm the safe and complete destruction of the viruses.[20] Poorly structured incinerator causes the release of pollutants in the outside environment. This leads to the production of different carcinogens like dioxins and furans and have been associated with a range of adverse human health effects.[21] In the absence of good resources, hazardous healthcare waste from small healthcare facilities can be buried in an area that has restricted public access. The burial pit needs to be well constructed as an inappropriately designed landfill may cause the pollution of surface and ground waters.[21] Piles of face masks, gloves in beaches can also threaten marine life. Medical and microbiological laboratory wastes do not only pollute the environment but may also facilitate the spread of infectious diseases such as Hepatitis, HIV/AIDS, cholera, typhoid, and respiratory complications.[21] Unsafe disposal of COVID-19 waste like used PPEs might escalate the spread of the virus via a secondary transmission.[20,22] In Delhi, the capital of India more than 40 sanitation workers have tested positive for the COVID infection, and 15 have lost their lives.

Waste management practices and challenges in Bangladesh

Due to the lack of proper documentation and monitoring practice, the management of medical waste remains neglected in Bangladesh. There is no integrated national policy on biomedical

waste management in Bangladesh. The government has introduced the Medical Waste Rule in November 2008 and revised the National Guideline for Medical Waste Management in 2016. [23] Even though it requires urgent attention at this time, many hospitals and laboratories do not establish proper waste disposal systems. A survey conducted in Dhaka found that most of the medical waste is being dumped openly in the City Corporation. In 2013, Standard in-house medical waste management was introduced in six medical college hospitals, seven specialized hospitals, and eight district hospitals in the country.[8] In Bangladesh, hospital waste is managed by the City Corporation, and other third party organizations. However, they have very poor capacities to manage the huge amount of waste along with domestic waste. There is not yet a proper estimation and identification of medical waste which is crucial to estimate the potential risk and develop a waste management plan. Most of the waste is collected by scavengers and waste collectors often working without any minimum protection. Around 40,000 informal waste collectors are working across the country[12] who are not aware of health hazards related to these wastes. They even do not follow any basic hygiene practices following exposure to medical waste.

In Bangladesh, although the volume of waste increased significantly, the reduction of waste management workers to half in the period of lockdown creates a big challenge for the country. Moreover, only three among the five incinerators installed in the country are functioning.[4] A large number of doctors, laboratory researchers, technologists, and other health care workers associated with the process of diagnosis and treatment of COVID-19 are at a great risk of infection. On July 30, the Bangladesh Medical Association stated that 2,458 doctors and 7,086 health workers are affected by SARS COV-2, which is increasing every day.[24] In these circumstances, it is of utmost importance to train all the frontline healthcare providers and waste management workers regarding proper handling and disposal of biomedical waste produced during the pandemic. Provide necessary personal protective equipment such as masks (3-layer masks, N95 masks, surgical masks), heavy-duty gloves, rubber boots, disposable workwear (overalls) suit, goggles, faces-shields, and hair cover/caps to waste management workers.[4]

Waste Management in COVID Testing Laboratories in Bangladesh

According to the Directorate General of Health Services (DGHS) of Bangladesh, 109 laboratories are now working for the testing of COVID- 19 samples through RT-PCR (reverse transcriptase-polymerase chain reaction).[25] Handling, processing, and disposal of COVID-19 related wastes should strictly adhere to the protocol as guided by the World Health Organization.[26] The authors have experienced in working and/or visiting two COVID-19 RT-PCR testing laboratories under the Chattogram Veterinary and Animal Sciences University (CVASU) and Chattogram Medical College hospital (CMCH) in Chattogram city, Bangladesh. Sample preparation and PCR test have done in two separate rooms in CVASU and in CMC four rooms used for every step from sample mixing to PCR run and reading. Plastic bins containing biohazard bags are used for putting wastes. One bin placed below the biosafety cabinet, especially for the wastes from the cabinets. Another bin used for all other wastes of the laboratory like hand gloves, face masks, tissues, as well as other materials. After performing the tests, the extra samples have placed in a biohazard bag. All biohazard bags are then sealed and autoclaved at 121 degrees centigrade temperature for 20

minutes. Finally, these bags are dumped in another large bag in a separate temporary storage room. In CVASU, waste bags are then collected by City Corporation workers. CMC has its own incinerator so they dispose of all waste bags by incineration. Reusable PPE gowns are washed in a washing machine sets inside the laboratory and the final wastewater is also autoclaved before releasing into the environment.

CONCLUSION

Healthcare providers and waste management workers are at high risk of secondary infection by hazardous healthcare waste. However, proper handling and disposal of excess amount of biomedical waste using limited resources and manpower during the pandemic is a great challenge for countries like Bangladesh. The practice of handling and disposal of COVID-related wastes were varied in laboratories. Proper dissemination of guidelines, protective equipment, and training on waste management could reduce the risk of public health hazards. Therefore, it needs inter-sectoral collaboration from the government, hospital and laboratory administration, research institutes, and other regulatory bodies.

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