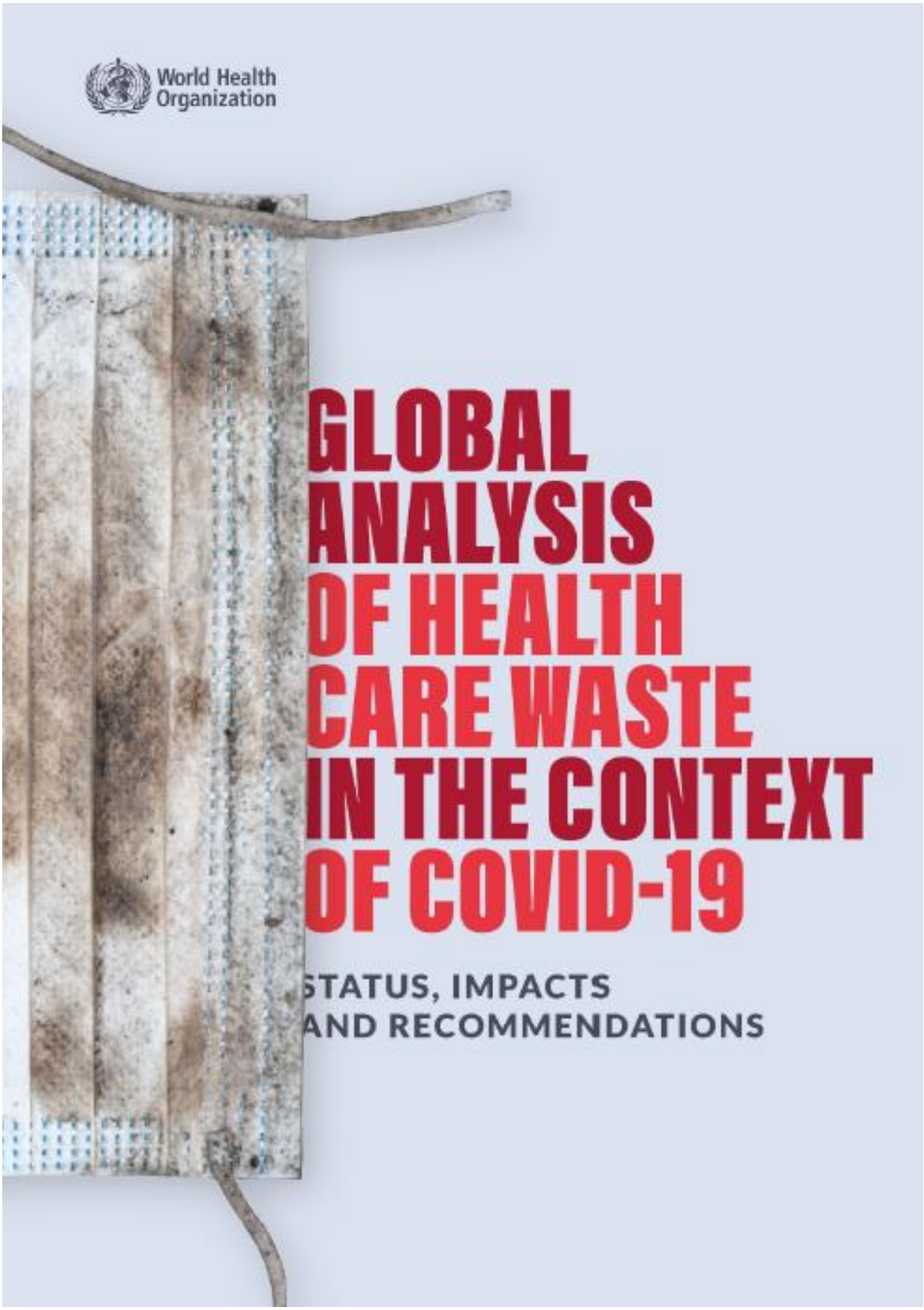


CASE STUDIES

IMPLEMENTING HEALTHCARE WASTE RECOMMENDATIONS CASE STUDIES

This document includes 12 diverse case studies that illustrate solutions to more safely and sustainably managing COVID-19 waste, and healthcare waste more broadly, in the spirit of “building back better”. They provide an opportunity to build and strengthen sustainable healthcare waste systems. These case studies are also included in the 2021 WHO publication “*Global Analysis of health care waste in the context of COVID-19: Status, impacts and recommendations*”.

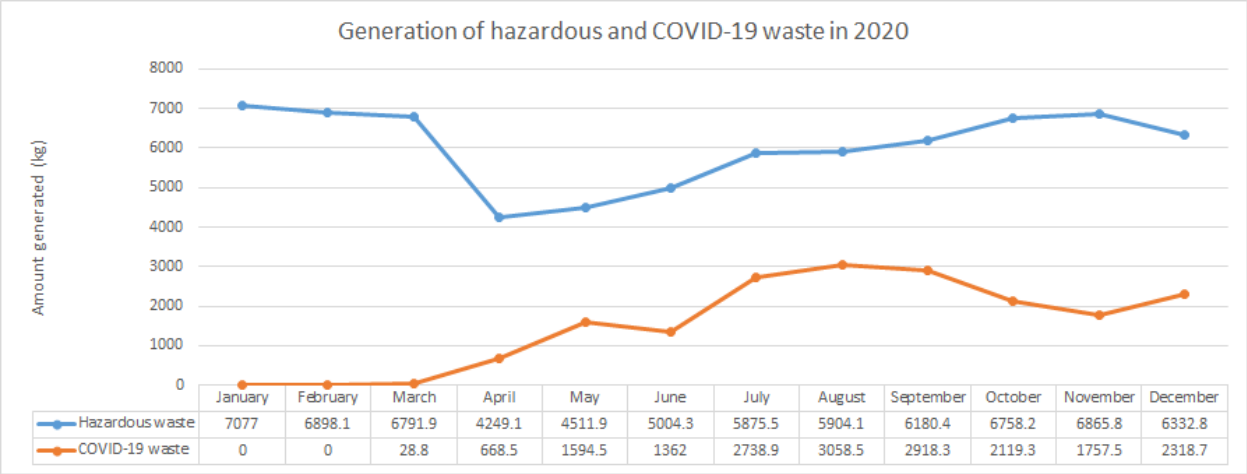
Columbia	Facility-led initiatives and recommendations to combat the increase in COVID-19 waste
England	Overuse of gloves in health care associated with cost and carbon emissions
Ghana	Multi-stakeholder efforts to respond to COVID-19
India	Improving waste segregation to reduce the quantity of waste incinerated and other innovations to increase recycling of waste
Lao PDR	Catalysing COVID-19 funding to finance environmentally sustainable healthcare facilities, including low-cost autoclaves in primary healthcare centres
Liberia	A comparison of waste management during the Ebola and COVID-19 health emergencies
Madagascar	Strategic provision of medical waste management during the COVID-19 pandemic
Malawi	Use of reverse logistics to deal with increased waste from COVID-19 and HIV testing
Nepal	Use of alternative waste treatment technologies and recycling of vaccination waste
Philippines	Public hospitals addressing healthcare waste in environmentally sustainable ways
Uganda	Providing PPE needs to be accompanied by appropriate waste management practices and resources
Western Europe	COVID-19 lockdown measures disrupting waste recycling and straining waste management capacity in world’s wealthiest countries

CASE STUDIES

Colombia: Facility-led initiatives and recommendations to combat the increase in COVID-19 waste

Fundación Clínica Infantil Club Noel, a medium-sized tertiary hospital located in south-west Colombia, undertook a number of activities to strengthen its waste management in response to COVID-19. First, the facility undertook training to raise awareness among staff on biosafety, management of PPE, patient care, cleaning and disinfection, and laundry and waste management in COVID-19 care areas. Protocols for managing COVID-19 waste were reviewed. It was agreed that COVID-19 waste should be managed in the same way as "normal" infectious waste, through decontamination and deactivation of the microbiological load by shredding and microwave technology. Sharps and pathological waste were incinerated according to Colombian regulations.

Although the use of disposable PPE was reduced in favour of reusable PPE, there was no reduction in the overall volume of waste. In fact, waste increased by 30% between 2019 and 2020: in 2019, an average of 5818 kg of hazardous waste – including infectious waste - was generated per month, compared with 7585 kg in 2020. Infectious waste increased by 27% in 2020 in comparison to 2019 (Fig. A1).



	January	February	March	April	May	June	July	August	September	October	November	December
Hazardous waste	7077	6898.1	6791.9	4249.1	4511.9	5004.3	5875.5	5904.1	6180.4	6758.2	6865.8	6332.8
COVID-19 waste	0	0	28.8	668.5	1594.5	1362	2738.9	3058.5	2918.3	2119.3	1757.5	2318.7

Fig. A1. Hazardous and COVID-19 waste generation in Colombia, 2020

Major challenges faced by the facility include inadequate separation of waste at the source; increased reliance on plastic supplies, which cannot be recycled, by the health sector; and the added burden of an increased patient load and thus quantity of waste. Recommendations to tackle these include the following.

- Implement sustainable purchasing that takes into account the economic and socio-environmental impact of consumables; takes into account the cost, benefit and quality of items; limits the use of plastic-containing items because of their environmental impact; and favours purchase of PPE that can be decontaminated or reprocessed for reuse.
- Continue to treat infectious waste using available microwave (or autoclave) technologies that are environmentally friendly.

- Strengthen education within the facility (including through visual reminders, training and incentives) to generate awareness about safe waste management and proper use of PPE.
- Develop policies to regulate the quantity and use of plastic packaging for medical devices.
- Review national guidelines to include more environmentally sustainable products and practices for cleaning and disinfection (e.g. use of low volatile organic compound glass cleaners, effective cleaning and appropriate targeting and application of disinfectants).

CASE STUDIES

England: Overuse of gloves in health care associated with cost and carbon emissions

In the first 6 months of the COVID-19 pandemic in England, use of PPE alone added an additional 1% carbon burden, compared with pre-COVID-19 *(37)*. Between February and August 2020, 3 billion items of PPE were used, resulting in 591 tonnes of waste per day. The greatest contribution came from gloves. Much of this PPE use was unnecessary.[1] Modelling showed that it was possible to reduce this environmental cost by 75% through a combination of strategies, including rational glove use, domestic manufacturing, using reusables where possible, and optimizing waste management by decontamination of contaminated PPE before recycling or waste-to-energy incineration *(37)*.

Efforts in 2019 in England to reduce unnecessary glove use through a campaign titled "Gloves off: safer in our hands" demonstrate that change is possible; it requires investment in training, improvement support and monitoring. After 1 year, glove orders fell by 3.7 million, creating savings of £90 000 *(49)* and reducing the amount of waste by 18 tonnes over 6 months. This strategy could have a greater impact if it is sustained long term and adapted to outbreak situations. Further evaluation is needed of its potential effectiveness in other settings and countries.

[1] Gloves in the healthcare setting are not required for most interactions, including checking vital signs, administering intravenous drugs and vaccinations. They should only be used when the healthcare provider is likely to touch blood, other body fluids or mucous membranes.

Ghana: Multi-stakeholder efforts to respond to COVID-19

Effective waste management practices, particularly in response to a pandemic, require efforts from multiple stakeholders. In Ghana, two technical briefs were developed and shared with the National COVID-19 Management Team, outlining why it is important to ensure effective healthcare waste management in the response to COVID-19 and providing a detailed explanation of the processes (and related standard operating procedures – SOPs) that need to be followed to effectively manage infectious waste for infection prevention *(50)*. One thousand posters, illustrating waste management SOPs, have been distributed throughout the country. The Waste Recovery Platform met to discuss the impact of COVID-19 in the waste management sector, agree on actions to address these challenges and mobilize stakeholders to support their implementation.

The Health Facilities Regulatory Authority carried out monitoring visits to 800 healthcare facilities in the Greater Accra and Ashanti regions to verify compliance with infection prevention and control protocols. Furthermore, three 3-day training sessions on infection prevention and control, including healthcare waste management (HCWM) and advocacy of the National HCWM Policy and Guideline have been conducted in 2020 and 2021 with the support of the United States Centers for Disease Control and Prevention.

Experts from the Accra School of Hygiene provided on-the-spot training for 12 000 healthcare personnel on effective healthcare waste management, based on gaps identified during previous monitoring exercises. To institutionalize the training, the Accra School of Hygiene inserted a semester course on HCWM in different diploma programmes (Environmental Health, Occupational Health and Safety, and Occupational Therapy). A short course for all allied health professionals in Ghana is planned in November 2021. The Ministry of Health trained staff from 20 hotels being used as quarantine and isolation centres in the Greater Accra Region on how to effectively manage their waste to prevent infections. The National Tourism Authority ensured that these guidelines were part of health and safety requirements for tourist facilities across the country.

A private company has been contracted to collect the infectious waste from all vaccination centres in Ghana and treat it using a centralised autoclave. Together with tutors and students from the Accra School of Hygiene, the safe handling of waste in the vaccination centres is supervised.

UNDP partnered with the Korle Bu Teaching Hospital to produce hand sanitizers locally and donated 11 150 litres of alcohol-based hand sanitizer to the Ministry of Health to support 21 facilities playing leading roles in the testing and management of COVID-19 cases across the country (Fig. A2) *(51)*. UNDP also procured consumables (bins, waste bags and sharps containers) and PPE for the Ministry of Health to promote effective management of medical waste in the selected healthcare facilities.

Scale-up of training, and sensitization to, and enforcement of, waste management guidelines are still needed. Financing for waste management is still inadequate. More

investment and budgetary allocation is needed to respond to the increased volume of waste being generated. Educational curriculums should be reviewed to strengthen healthcare waste components, including best available technologies and best environmental practices. This will help healthcare workers respond to future outbreaks.

Fig. A2. Grace Kankam, Supply Manager at the Central Medical Store of the Ministry of Health, Ghana, receiving alcohol-based hand sanitizers at the store for onward distribution to selected health facilities.

India: Improving waste segregation to reduce the quantity of waste incinerated and other innovations to increase recycling of waste

India generated approximately 101 tonnes of COVID-19-related health care waste per day during the first wave of the pandemic[2], in addition to the 609 tonnes of waste generated daily from routine health services (a total of 710 tonnes). Accordingly, the generated medical waste increased by 17% in that time. The total available capacity for incineration of COVID-19 waste in the country is 840 tonnes. New Delhi accounts for 11% of India's daily COVID-19 waste generation but has only two incinerators. During the first wave, 70% of this capacity was being used, and measures were needed to ensure that capacity was not exceeded. In a few cities with particularly high incidence of COVID-19, where regular waste facilities could not handle the increased volumes, waste was sent to industrial incinerators and centralized waste treatment centres.

To tackle the increase in waste generated, the Central Pollution Control Board, under the Ministry of Environment, produced a set of waste guidelines in 2020 that emphasized the importance of waste segregation. The ministry regularly amended the guidelines in an effort to further reduce the amount of waste incinerated and placed a greater focus on non-burn and environmentally sustainable technologies and practices, such as autoclaving, microwaving and recycling by state-approved facilities. Training in local languages on COVID-19-appropriate waste disposal and hygiene practices was conducted, and mass media communication was used to educate the general public on management of COVID-19 waste generated at home.

In tandem, the ministry launched a COVID-19 medical waste mobile application (Fig. A3) to track generated waste amounts, as well as transport and reception at the treatment centres. This includes tracking of waste vehicles to prevent theft of waste and unauthorized recycling of waste.

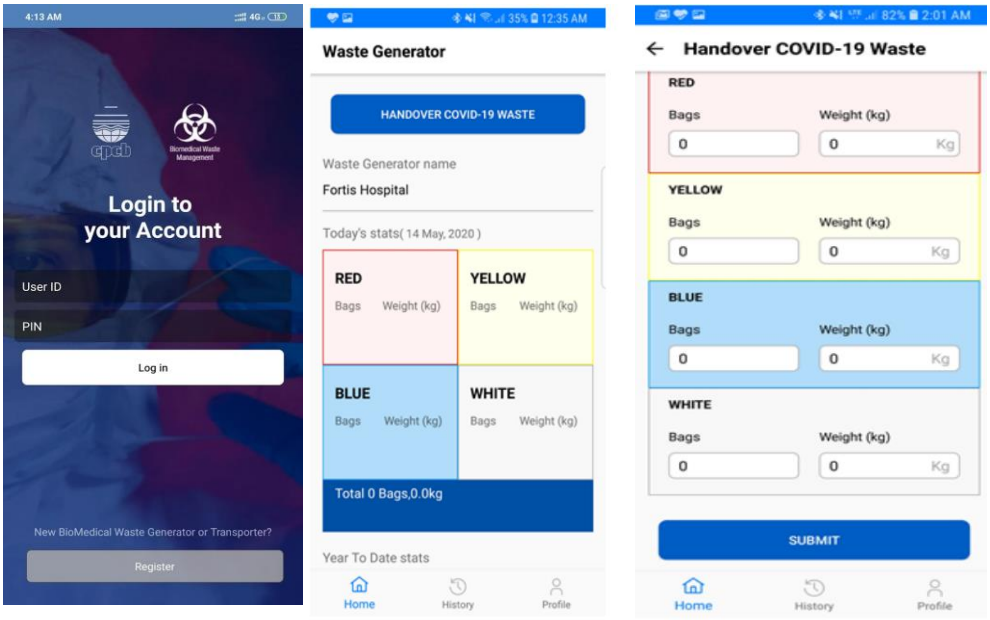
Since August 2020, data on the generated medical waste in each state have been published on a dedicated website each month *(54)*. As of June 2021, based on 198 biomedical waste treatment centres using the mobile app, approximately 13 000 generators of COVID-19 waste were registered. Data are submitted daily, and dedicated monitoring and control agencies can visualize the data submitted from different stakeholders.

A number of innovations have also been trialled during the pandemic; these include conversion of COVID-19 waste into clean energy (hydrogen fuel) using sunlight, and conversion of PPE waste into eco-friendly construction materials, including construction bricks, bituminous road surfaces and partial replacement of cement in concrete. Further evaluation of their impact is needed.

Waste management has proved particularly challenging in remote, rural areas where there are limited waste treatment and disposal facilities. In these areas, exceptions were made to allow waste disposal in landfills and deep burial (elsewhere, this is not

permitted). There is an urgent need to increase the number of authorized, trained waste recyclers to respond to the increase in waste generated. Overall, the emphasis on waste segregation by the Central Pollution Control Board resulted in less waste being incinerated, reducing the environmental impact.

Implementing a waste tracking system allows waste generators and authorities to identify the current waste streams and determine how much waste is generated, and what waste can be recycled or reused to reduce the environmental footprint. This information helps with planning adequate infrastructure such as storage, and required waste treatment capacities. Furthermore, it can support healthcare facilities to monitor adequate segregation and evaluate performance of the waste management system.



Source: Central Pollution Control Board *(53)*.

Fig. A3. Screenshots of the India COVID-19 medical waste tracking application

Lao PDR: Catalysing COVID-19 funding to finance environmentally sustainable healthcare facilities, including low-cost autoclaves in primary healthcare centres

Since 2017, the Government of Lao People's Democratic Republic has worked to implement a national vision, a coordination mechanism, policies and regulations to improve the resilience and sustainability of WASH and energy services in healthcare facilities that are prone to climate risks, particularly floods and droughts. New national standards for environmentally sustainable healthcare facilities were launched along, with the Climate Change and Health Adaptation Strategy, in 2018. Accountability for implementing these standards was strengthened by a call to build resilience in health systems after massive flooding in 2018 and the passing of the World Health Assembly resolution on WASH in healthcare facilities in 2019 *(55)*. A package of interventions for making hospitals "safe, clean, green and climate resilient" was introduced, and WASH and energy indicators were integrated into regular health systems monitoring. This allows rapid identification of gaps, and for the health sector and healthcare facility managers to be held accountable for maintaining adequate WASH and energy services.

These efforts provided a strong foundation for capitalizing on opportunities presented by COVID-19 to expose weaknesses in health systems and direct additional funding to address them. With leadership from the Ministry of Health, since 2020, more than US$ 2 million has been mobilized from a number of donors (the Global Environment Facility; WHO; the Pandemic Emergency Financing Facility of the World Bank; and the governments of Germany, Luxembourg, Australia and Japan) to scale up existing efforts on climate-resilient healthcare facilities, and to strengthen capacity for pandemic preparedness and response. More than 200 healthcare facilities nationwide have benefited. One important element was the installation of 70 low-cost autoclaves, which do not emit harmful pollutants (dioxins and furans). These low-cost autoclaves use as little as 3 L of water to treat 100–120 kg of waste. The green waste treatment technology was coupled with equipment for safe segregation and storage (e.g. bins, PPE for waste handlers), as well as training, supportive supervision and ongoing monitoring to help ensure long-term sustainability.

The effort in Lao People's Democratic Republic demonstrates how long-term systems strengthening can address basic infrastructure gaps, improve services to meet both health and climate standards, and use emergency funding and the pandemic to accelerate longer-term and environmentally sustainable improvements.

Liberia: A comparison of waste management during the Ebola and COVID-19 health emergencies

Proper healthcare waste management has been a challenge for Liberia for a long time. It was not prioritized until the outbreak of the Ebola virus disease in 2013, when it became obvious that there were limitations in the number of staff, resources and guidelines to deal with healthcare waste.

Efforts were made to ensure that the country was better prepared for health emergencies. First, there was widescale training of more than 700 healthcare workers across the 15 counties of Liberia from 2013 to 2016 using “Safe Quality Services” training. This covered waste management, WASH, relevant national health policies and quality improvement within healthcare facilities.

Second, locally produced De Montfort incinerators were constructed in more than 600 primary and secondary healthcare facilities (Fig. A4). National guidelines for the safe management of healthcare waste, SOPs and job aids were developed and operationalized, and approximately 1500 copies were disseminated across the country. Waste management infrastructure is now part of the remit of the Ministry of Health’s infrastructure unit and is standardized for use across the health system.

As a result, Liberia was better prepared at the onset of the COVID-19 pandemic by having more healthcare personnel with specialized training – more than 95 master trainers were trained to implement the guidelines and SOPs in line with COVID-19 and other routine service protocols. In addition, waste segregation has improved, as evidenced by the availability of a three-bin system in most healthcare facilities. Infectious waste is also properly handled by specialized staff (waste managers and incineration technicians) from healthcare facilities. Moreover, monitoring and supervision using WASH FIT are regularly conducted, and data are generated to inform decision-making across Liberia.

One of the main shortcomings has been the inability to quantify the waste generated from routine services and during health emergencies. Other challenges include an overdependence on donor funding, which is unsustainable; lack of regular maintenance of waste infrastructure, particularly incinerators; and lack of motivation of staff who handle waste. More training and supportive supervision are needed, particularly for operation and maintenance of existing infrastructure.

Fig. A4. Overseeing an incinerator in Liberia

Madagascar: Strategic provision of medical waste management during the COVID-19 pandemic

During the COVID-19 pandemic, a large amount of additional waste was produced in COVID-19 treatment facilities in Madagascar, including university hospitals, district reference hospitals, basic health centres, hospitals and COVID-19 treatment centres (CTCs). Following a second wave of COVID-19 in March 2021, the number of COVID-19 patients exceeded the capacity of hospitals, requiring a massive recruitment of doctors, paramedics and support staff.

There are five CTCs in Antananarivo, the capital of Madagascar, which on average each generated 1 tonne of infectious waste every 3 days between March and June 2021. To ensure the management of COVID-19 waste, materials (waste garbage cans, waste bags, disinfectants, PPE, cleaning materials) and human resources were made available to each facility. Faced with the health emergency and the opening of CTCs, which are non-hospital centres that do not have the specific personnel or resources required, the Health and Environment Service was mandated by the Ministry of Public Health to ensure the implementation of infection prevention and control measures (IPC/WASH) in the CTCs of Antananarivo. In addition to mobilizing resources for IPC/WASH activities throughout Madagascar, the Health and Environment Service was responsible for training hygiene workers in cleaning, disinfection and waste management. Because of the large amount of infectious waste generated by the pandemic, waste was sent to a centralized disposal unit with the required capacity (Fig. A5).

Fig. A5. Transport of waste from Ankorondrano CTC (left) and waste storage at Village Voara CTC (right)

To help cope with the excess waste generated in Antananarivo, a partnership was established between one of the CTCs and a nearby airport with a high-performance incinerator. The incinerator was repurposed to treat infectious waste generated by the CTC by order of the Ministry of Health. For the other four CTCs, waste was sent to waste disposal units in nearby hospitals that had incinerators and/or autoclaves. After 3 months, material that had not been sufficiently burnt in incinerators (approximately 10 tonnes) was transported and disposed of in a large pit at Manakavaly Hospital, a hospital with land available for this purpose.

Additional human, material and financial resources were required to respond to COVID-19. Much of this need was met by development partners who provided supplies (e.g. waste bins and bags) for CTCs and quarantine facilities, and transported waste for centralized treatment. There were further challenges relating to the availability of water and handwashing facilities for wasteworkers; PPE for support staff; vehicles for transporting waste; and disposal units for the huge amount of infectious waste generated in healthcare facilities, in non-hospital centres and at the household level (from home treatment of asymptomatic positive cases). The high volume of people using sanitation facilities in quarantine facilities also resulted in large volumes of faecal sludge that needed treating.

CASE STUDIES

Malawi: Use of reverse logistics to deal with increased waste from COVID-19 and HIV testing

Although policies for waste management exist in Malawi, implementation is hindered by the lack of resources, infrastructure, dedicated attention and policing. Diagnostics used in HIV programmes and COVID-19 testing have resulted in additional waste volumes and new waste challenges; these include increased levels of hazardous chemicals such as guanidinium thiocyanate (GTC) from PCR cartridges for SARS-CoV-2 testing, which require special treatment for safe disposal. Riders For Health (R4H) Malawi, a local nongovernmental organization, supports waste management in 44 healthcare facilities across the country. In addition to providing supplies and technical support, R4H conducts reverse logistics to transport GTC, using motorbikes, for treatment at a centralized high-spec, high-temperature pharmaceutical incinerator. The reverse logistics system in this example is a combination of delivering goods to the healthcare facilities and taking back waste using the same transport vehicle and personnel to save resources. It is based on a "hub and spoke" model (see Fig. A6) to connect the 44 facilities with the least possible travel across a developed transport network; the longest distance from a facility to the incinerator is 690 km. From 2019-2021, 3,800 kg of GTC-contaminated waste was transported for incineration, enabling all testing facilities to comply with the national Good Clinical Laboratory Practice and minimize their environmental impact. Although the lack of resources available impedes day-to-day implementation, this model helps to lessen the burden on smaller, more remote facilities that do not have the necessary infrastructure to treat and safely dispose of waste.

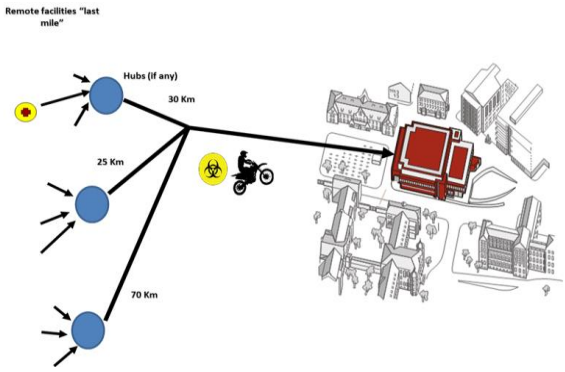


Fig. A6. "Hub and spoke" reverse logistics model

Nepal: Use of alternative waste treatment technologies and recycling of vaccination waste

Remote, rural facilities, including those in Nepal, often struggle with safe management and treatment of vaccine waste. Facilities from the periphery of Kathmandu Valley regularly request help to manage safety boxes, which frequently pile up around vaccination sites and health posts. Open burning of safety boxes is still the main treatment option in many places, posing health and environmental risks. Data on the quantity of waste generated are rarely collected, which makes planning for waste management more difficult. A partner organization, Terre des hommes, has piloted a method for measuring waste in three rural healthcare facilities. Waste produced from the delivery room, from the outpatient department and by facility staff was segregated and collected in plastic bags. Waste generated over a 24-hour period was transferred for digital weighing, and a new plastic bag was replaced at the point of collection to collect the waste for the next 24 hours. The number of people who produced the waste each day was also recorded. This continued for 7 consecutive days. This tracking effort allowed facilities to identify where segregation could be improved, thereby reducing the amount of waste that needs to be treated.[3]

To address poor vaccine waste management in Kathmandu Valley, the Ministry of Health asked WHO Nepal to support safe management and treatment of vaccine waste. The waste management strategy involved the safe collection, storage, treatment and disposal of safety containers, as well as use of two non-burn technologies: microwaving and autoclaving. The estimated cost for the packaging, collection, safe storage and treatment of 1500 sharps boxes included in the effort was about US$ 15 000 (about US$ 10 per sharps box). Of the 1500 safety boxes collected,[4] 613 were taken to a nearby hospital and treated using a microwave with an inbuilt shredder (Fig. A7). Decontamination and shredding rendered the waste unrecognizable, allowing it to be sent directly to the landfill site as normal nonhazardous waste. This option had fast treatment cycles and was easy to implement, but the waste could not be recycled. The remaining boxes were sent to a local maternity and women's hospital, and treated in a 227-litre pre-vacuum autoclave (Fig. A7). This method had longer treatment cycles and slightly higher operational costs, but had the benefit of producing decontaminated plastic waste that could be recycled – syringes were cut with needle cutters, leaving the plastic part for recycling (about 95% of the decontaminated waste).

[3] More details of the methodology and results can be found at www.washinhcf.org/resources/XXX.
[4] One safety box contains approximately 100 used syringes and corresponding empty vials.

Fig. A7. (a) Collection of safety boxes in drums. b) Shredded waste after microwaving. c) Loading of the autoclave.

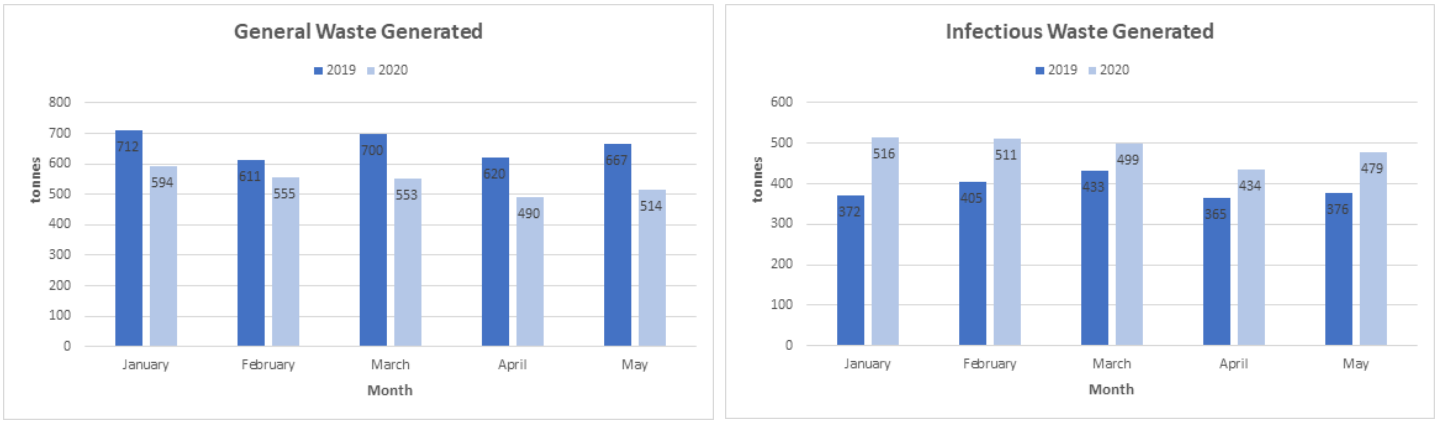
A number of challenges were faced: ideally, needles should be cut at the place of generation to prevent unnecessary risk to waste workers using autoclaves. However, at the time of implementation, this system had not been fully set up, and needle cutters were not available at the points of vaccination. Some vaccines were delivered in prefilled glass syringes; since needle cutters cannot be used for glass, these syringes could not be recycled. Plastic from the syringes can be sold for recycling, generating some revenue and saving environmental costs of disposal. However, revenue is not sufficient to cover the entire operational costs of autoclaving, and thus additional financing is needed. Finally, financial and human resources were insufficient. Safe waste management requires investment by the government and a national waste plan, including specific guidance for COVID-19 vaccines *(56)*.

The safe vaccine waste management effort in Nepal demonstrates that organizations providing vaccines should plan for and provide financing for the additional costs of waste management, plan for and support needle cutters from the outset of the system, and procure products that can be recycled.

Philippines: Public hospitals addressing healthcare waste in environmentally sustainable ways

The Philippines' Department of Health (DOH) updated its Health Care Waste Management Manual (2020) and issued the Green and Safe Health Facility Manual (2021). The two manuals offer a guide for healthcare facilities to reduce their environmental footprint through climate-friendly technology and initiatives. They were published along with new guidelines on infection prevention and control measures (including waste) for healthcare facilities that are designated COVID-19 referral or accepting hospitals, and temporary treatment and monitoring facilities. The manuals call for environmentally sustainable procurement, including waste prevention and reduction at source, and the use of WASH FIT (see box in section 4.2.2) to help facilities make improvements *(42)*.

A study of compliance with waste management performance standards during the COVID-19 pandemic, conducted in 51 DOH hospitals, showed an increase in waste generated in hospitals between 2019 and 2020 (see Fig. A8).



Source: Ruiz et al. *(57)*

Fig. A8. General and infectious waste generated in Philippine hospitals, 2019 and 2020

The survey found a 25% increase in infectious waste and a 13% decrease in general waste in 2020, compared with 2019. Overall, an additional 70 tonnes of waste was generated during that time by the 51 hospitals (an average of 1.4 tonnes per hospital – an increase of 12%). Data on waste generated during COVID-19 were also collected at five facilities in Metro Manila from emergency rooms, intensive care units and medical wards. Across all hospitals, 50% of waste was infectious (an increase of 10–20% during the pandemic), while 18% of the total waste was PPE, of which 51% were gloves.

The healthcare facilities facing an increased amount of infectious waste responded in a variety of ways. Some hospitals amended their annual contracts with service providers to collect larger volumes of waste, whereas others began to disinfect infectious waste at the point of generation using sodium hypochlorite *(58)*. Waste disinfected with chemicals should not be incinerated or autoclaved because acidic fumes generated

pose a risk for the operator and can damage the equipment. In some cases, local governments help with collection and disposal of general waste. The DOH subsequently issued interim guidelines on the management of healthcare waste in healthcare facilities and on waste generated during COVID-19 vaccination *(59, 60)*. The national government has supported facilities in retrieving empty and expired COVID-19 vaccine vials as part of a reverse logistics strategy.

CASE STUDIES

Uganda: providing PPE needs to be accompanied by appropriate waste management practices and resources

Early in the pandemic, severe global shortages of PPE led to rationing and prioritization. Five organizations (Direct Relief, the Community Health Impact Coalition, the Community Health Acceleration Project, the Pandemic Action Network and VillageReach) came together in June 2020 to form the COVID-19 Action Fund for Africa (CAF-Africa) to address this gap on the African continent. The aim was to deliver PPE to community health workers on the front lines of the pandemic who were often not seen as a priority for support. As an emergency response effort, CAF-Africa was able to mobilize quickly to supply PPE on a larger scale than any of the partners could have done alone. Between August 2020 and June 2021, CAF-Africa reached nearly 500,000 community health workers in 18 countries, delivering 81.6 million units of PPE, including surgical and N95 masks, gowns, face shields and eye protection.

Safely disposing of and treating this PPE waste was problematic, in part because waste management was not planned or resourced. VillageReach did carry out an evaluation of the classification, treatment and disposal methods in Uganda for the purposes of this document. Besides reusable PPE like 1.6 million reusable gowns and 3.7 million goggles or face shields, CAF-Africa delivered 9.5 million disposable face masks and pairs of gloves to Uganda [COVID-19 Action Fund for Africa (CAF) 2021]. Out of the 14 health centres which provided information, 11 classified the waste as infectious and 3 as non-infectious. All the facilities used burn technologies to treat their waste: seven facilities used open burning, three used small scale incineration, three facilities treated waste outside the facility and only one facility practiced high temperature incineration. Open burning is particularly problematic as it releases toxic furans and puts waste handlers at risk of burns. The result of this evaluation highlights two important findings. First, the existing health care waste regulations and practices for segregation and treatment are sub-optimal and not completely enforced in Uganda. The second is that this intervention, like other PPE efforts, ought to have provided human and financial resources to safely segregate and treat waste as part of wider end-to-end waste cycle operations. More efforts are needed to sensitize health partners and disseminate existing national standards and health care waste alongside increasing budgets, as part of any procurement effort, to safely reduce, manage and treat health care waste.

Western Europe: COVID-19 lockdown measures disrupting waste recycling and straining waste management capacity in world's wealthiest countries

In western Europe, most countries classify all waste generated during the treatment of COVID-19 patients as infectious. The prevalent technology for the treatment of hazardous waste (including infectious waste) is centralized, advanced incineration. Environmentally sustainable treatment technologies such as autoclaving are used in several countries, including Germany, France and Sweden. Waste from households with patients in quarantine or confirmed COVID-19 cases is classified as normal household waste and should be treated by incineration (thermal recovery). Household waste is collected and managed by professional private or municipal waste services where workers, generally, have adequate PPE and equipment.

In the first few months of the COVID-19 pandemic, countries across Europe faced challenges with collection and sorting services, such as staff shortages; temporary disruptions to, or reduced frequencies of, collection of certain waste streams; physical access limitations to waste recycling centres; and the need for safe handling of waste from households with COVID-19 cases. In response, many countries suspended occupational health requirements, allowing longer working times, transport using normal waste bins and trucks, and treatment of infectious waste at municipal waste sites.

The European recycling industry in Europe claimed that the lockdown measures undermined the circular economy.[5] Less segregation of waste occurred, and recycling centres where domestic recyclables can be dropped off were closed to the public, leading to fewer recyclable materials and therefore fewer materials produced from recyclables.

The lesson was that countries with an integrated circular economy need to invest in and develop contingency plans for the continuous operation of the recycling industry to ensure that sufficient recycled materials are available for the production of new goods – even in times of crisis. Reliable collection of municipal waste is also essential to sustain waste disposal and hygienic environments to prevent the spread of infectious pathogens. The waste management sector should be considered an essential service or "systemically relevant infrastructure" during future outbreaks or crises.

[5] A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimizing the generation of waste (https://ec.europa.eu/eurostat/web/circular-economy).

REFERENCES

Reference numbers 1-36 are included in the main report.

37. Rizan C, Reed M, Bhutta MF. Environmental impact of personal protective equipment distributed for use by health and social care services in England in the first six months of the COVID-19 pandemic. J Roy Soc Med. 2021;114(5):250–63. doi:10.1177/01410768211001583.

38. Policy paper. Personal protective equipment (PPE) strategy: stabilise and build resilience [website]. London: Department of Health & Social Care; 2020 (https://www.gov.uk/government/publications/personal-protective-equipment-ppe-strategy-stabilise-and-build-resilience/personal-protective-equipment-ppe-strategy-stabilise-and-build-resilience, accessed 10 November 2021).

39. Wilson A. Robust response to PPE shortages in Germany. Innovation in Textiles. 20 July 2020 (https://www.innovationintextiles.com/robust-response-to-ppe-shortages-in-germany/, accessed 10 November 2021).

40. Assessment of the COVID-19 supply chain system (CSCS): summary report. The Yellow House; 2021 (https://www.who.int/publications/m/item/assessment-of-the-covid-19-supply-chain-system-report, accessed 10 November 2021).

41. Country progress tracker. In: WASH in Health Care Facilities [website]. Geneva: World Health Organization and United Nations Children's Fund; 2021 (https://washinhcf.org/country-progress-tracker/, accessed 8 November 2021).

42. World Health Organization, United Nations Children's Fund. Water and Sanitation for Health Facility Improvement Tool (WASH FIT). Geneva: World Health Organization; 2018 (https://www.who.int/publications/i/item/9789241511698, accessed 10 November 2021).

43. Improving hand hygiene through a multimodal strategy. In: Resource considerations for investing in hand hygiene improvement in health care facilities. Geneva: World Health Organization; 2021: Annex (https://www.who.int/publications/i/item/9789240025882, accessed 10 November 2021).

44. Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. Geneva: World Health Organization; 2016 (https://www.who.int/publications/i/item/9789241549929, accessed 10 November 2021).

45. Minimum requirements for infection prevention and control programmes. Geneva: World Health Organization; 2019 (https://www.who.int/publications/i/item/9789241516945, accessed 10 November 2021).

46. Stemming the superbug tide: just a few dollars more. Paris: Organisation for Economic Co-operation and Development; 2018

CASE STUDIES

(https://www.oecd.org/health/stemming-the-superbug-tide-9789264307599-en.htm, accessed 20 November 2020).

47. Overview of technologies for the treatment of infectious and sharps waste from health care facilities. Geneva: World Health Organization; 2019 (https://apps.who.int/iris/bitstream/handle/10665/328146/9789241516228-eng.pdf, accessed 10 November 2021).

48. Core questions and indicators for monitoring WASH in health care facilities in the Sustainable Development Goals. Geneva: World Health Organization and United Nations Children's Fund; 2019 (https://washdata.org/sites/default/files/documents/reports/2019-04/JMP-2018-core-questions-for-monitoring-WinHCF.pdf, accessed 10 November 2021).

49. Mitchell G. Glove crackdown saves trust GBP 90 K and reduces waste. Nursing Times. 7 August 2019 (https://www.nursingtimes.net/news/hospital/glove-crackdown-saves-trust-90k-and-reduces-waste-07-08-2019/, accessed 10 November 2021).

50. Effective health care waste management processes and actions for COVID-19 response. Accra: Ministry of Health, Republic of Ghana, and United Nations Development Programme; 2020 (https://greenhealthcarewaste.org/wp-content/uploads/2020/12/Ghana-Project-Brief-HCWM-for-National-COVID-19-response.pdf, accessed 10 November 2021).

51. UNDP supports local production of hand sanitizers for Ghana's COVID-19 response [website]. Accra: United Nations Development Programme; 2020 (https://www.gh.undp.org/content/ghana/en/home/presscenter/pressreleases/2020/undp-supports-local-production-of-hand-sanitizers-for-ghanas-cov.html, accessed 10 November 2021).

52. Central Pollution Control Board, National Green Tribunal report, July 2020

53. User manual: Android mobile application & web application – COVID19BWM, COVID-19 biomedical waste tracking app, version 1.0. Delhi: Central Pollution Control Board; 2020 (https://cpcb.nic.in/uploads/Projects/Bio-Medical-Waste/V1_COVID-19_BMW_Tracking_App.pdf, accessed 10 November 2021).

54. COVID-19 biomedical waste management status. In: COVID-19 waste management [website]. Delhi: Central Pollution Control Board; 2021 (https://cpcb.nic.in/covid-waste-management/, accessed 10 November 2021).

55. Resolution WHA72.7. Water, sanitation and hygiene in health care facilities. In: Seventy-second World Health Assembly, Geneva, 20–28 May 2019. Resolutions and decisions, annexes. Geneva: World Health Organization; 2019 (WHA72/2019/REC/1; https://apps.who.int/gb/ebwha/pdf_files/WHA72-REC1/A72_2019_REC1-en.pdf#page=15, accessed 10 November 2021).

CASE STUDIES

56. World Health Organization, United Nations Children's Fund. COVID-19 vaccination: supply and logistics guidance – interim guidance. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/339561, accessed 10 November 2021).

57. Ruiz JP, Cruz G, Napulan R. Sustainable design principles development and practices of DOH hospitals towards climate-smart health facility. Academia Letters. 2021; article 1222. doi:10.20935/AL1222.

58. Cabico GK. "Earth not healing": medical waste piles up as COVID-19 cases rise. Philstar Global. 15 August 2020 (https://www.philstar.com/headlines/2020/08/15/2034986/earth-not-healing-medical-waste-piles-covid-19-cases-rise, accessed 10 November 2021).

59. Interim guidelines on the management of health care wastes generated from COVID-19 vaccination. Manila: Department of Health, Republic of the Philippines; 2021 (https://doh.gov.ph/sites/default/files/health-update/dm2021-0031.pdf, accessed 10 November 2021).

60. Interim guidelines on the management of health care waste in health care facilities, community quarantine units, and temporary treatment and monitoring facilities with cases of coronavirus disease 2019 (COVID-19). Manila: Department of Health, Republic of the Philippines; 2020 (https://doh.gov.ph/sites/default/files/health-update/dm2020-0170.pdf, accessed 10 November 2021).