CASE STUDY

NEPAL

USE OF A NON-BURN APPROACH TO MANAGING CONTAMINATED WASTE (SHARPS) GENERATED FROM COVID-19 VACCINATION IN THE KATHMANDU VALLEY

Abstract:
This case study from Nepal describes a pilot study carried out to collect and transport large quantities of vaccine waste from COVID-19 vaccination sites in the Kathmandu valley to secure storage and eventually to a designated health facility equipped to treat and dispose of waste using non-burn technology.

COVID-19 Vaccine
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Global challenges in COVID-19 vaccination

The massive scale of COVID-19 vaccination activities generates vast quantities of waste consisting of vaccine vials, sharps waste, and other ancillary waste. This poses a challenge for countries with limited resources and capacity to safely manage and process the waste for final disposal in a manner safe for health and the environment. In general, disposal of COVID-19-related waste should follow the practice used for other healthcare and vaccination-related wastes, in accordance with national policies, guidance, and standards.[1]

During the short period available to countries to prepare for COVID-19 vaccination, the treatment and disposal of the large quantities of healthcare waste resulting from COVID-19 vaccination programmes were not always prioritized as countries focused on vaccine deployment to reach the priority populations. Consequently, adequate measures to handle waste safely and appropriately were often not in place before deployment. Additionally, the volume of waste generated by COVID-19 vaccination of frontline workers, elderly and adult populations was significantly higher than that generated during routine immunization and the capacity of existing waste management systems was often insufficient. The surge capacity in this area was often not planned for.

Safe management of health care waste involves three key principles: (i) reduction of unnecessary waste; (ii) separation of general waste from hazardous waste; and (iii) treatment and safe disposal of the waste using a process that reduces risks to health workers and communities. Failure to address the issue of immunization waste can result in injury to scavengers and trigger serious environmental and biological hazards.

As a general rule, WHO recommends[2] that the methods for final disposal of sharps, vials, and personal protective equipment (PPE) should be safe, respect the environment and be in compliance with national laws, regulations, and codes on health and safety, as well as with international conventions. Generally, selected methods should minimize the formation and release of toxic chemicals or other hazardous emissions. More specifically, sharps and hazardous waste should preferably be treated using non-burn technology, such as autoclave, followed by disposal or recycling of the treated waste, or incineration using a dual chamber incinerator with flue gas treatment. Dual or single-chamber incineration without flue gas treatment can be used as an interim solution.

Burning in a pit and burying can be used as a last resort option in low-resource settings. Non-infectious, or treated waste, including cut syringes, can be recycled if a safe and effective recycling system is in place and per national policies and guidance.

1 In some very low-resource settings, the local/national guidance may be lacking, or it may be difficult to meet national standards and/or international conventions. In such cases, every effort should be made to select the inter-im solutions which would, as much as possible, reduce risks to human and environmental health and incrementally improve them to meet the standards and policies/regulations.

2 https://www.who.int/publications/m/item/management-and-safe-disposal-of-covid-19-vaccination-waste-at-health-facility-level

It is understood that functional dual-chamber incinerators with flu gas treatment options may not be feasible for all countries but may be of interest to those seeking an environmentally friendly approach to the disposal of larger quantities of healthcare waste generated by COVID-19 vaccination.

Background & context: Nepal

Following the declaration of the COVID-19 pandemic by WHO, in early 2021, Nepal's Ministry of Health and Population (MoHP) prepared its National Deployment and Vaccination Plan (NDVP). According to the plan, enough doses to vaccinate 20% of the population at the highest risk of COVID-19 disease and death through the COVAX facility were to be secured. Under the first COVAX allocation, the COVAX facility delivered 348 000 doses as the first shipment to the country in March 2021. The Government of Nepal also secured an additional 2.8 million doses of the ChAdOx1 (Covishield™) vaccine and SARS-CoV-2 inactivated vaccines (Sinovac-Coronavac™ and COVID-19 vaccine – BIBP) through direct procurement.

Nepal launched the COVID-19 vaccination campaign on 27 January 2021 and as of 13 December 2022, had administered the complete primary series of vaccination to 82% of the total population, and the first booster dose to 30% of the total population.

Based on its robust routine immunization system, experience with conducting nationwide mass vaccination campaigns, and high vaccine acceptance in the community at large, Nepal safely and successfully implemented a rapid rollout of COVID-19 vaccination. However, the large quantity of healthcare waste resulting from vaccinating a target population wider than that for routine immunization was not adequately planned for and there were concerns over the mishandling of the waste containing safety boxes and haphazard disposal practices resulting in needle stick injuries and risk to both public and environmental health. Visits to vaccination sites showed safety boxes scattered around the vaccination sites, some of which were open with syringes spilling out. These boxes were being accessed by scavengers who were removing needles with their bare hands to collect the syringes for recycling. Untreated syringes were also seen to be being used for a variety of inappropriate purposes including candy dispensers being sold by street hawkers.

In response to the observations on the improper handling of the safety boxes, a pilot project was conducted in a rural and low-resource setting (periphery of the Kathmandu Valley) with the main objectives of identifying challenges, efficiencies, and best practices for managing waste during mass vaccination with due consideration to safety, efficiency, and protection of the environment. It should also be noted that there are restrictions on burning or incinerating waste in the Kathmandu Valley, therefore this was not considered to be a viable option by law burning technology is discouraged in Nepal.

Nepal's innovative response

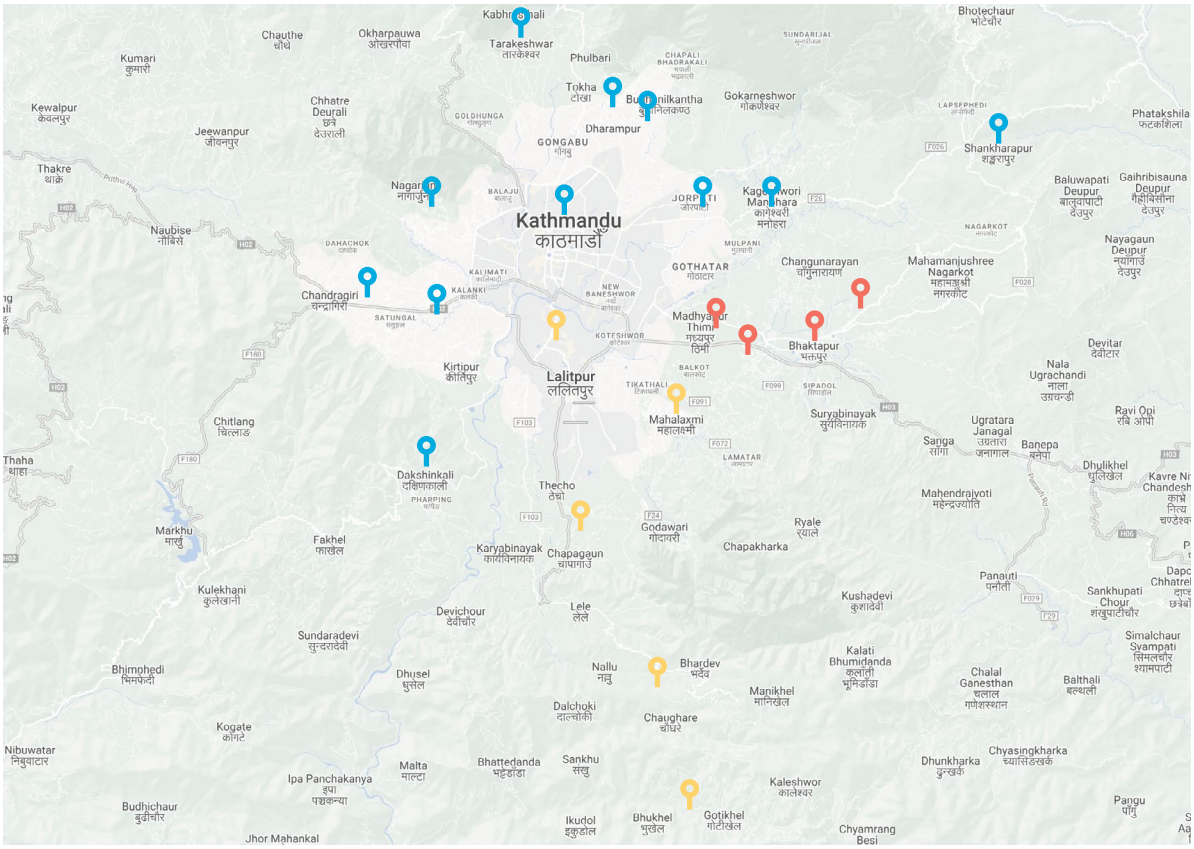
At the initiation of Family Welfare Division, coordination and request of the MoHP, with financial support from WHO Nepal, the pilot project was implemented with technical support from Health Environment and Climate Action Foundation (HECAF360). The project had two main phases: (i) needs assessment and setting-up; and (ii) implementation.

1. NEEDS ASSESSMENT & SETTING UP

Step 1 — Assessment. Visits to vaccination sites in health posts were conducted to assess current practices in waste management after mass vaccination, the magnitude of waste generated, and how it was stored. The information gathered was used to plan the equipment and activities needed for optimizing waste disposal. **Preparatory meetings** were held with stakeholders such as the Family Welfare Division, the Sukraraj Tropical and Infectious Disease Hospital, the Civil Service Hospital, the Paropakar Maternity and Women's Hospital, and WHO Nepal to discuss the overall project. **Information was collected** from the staff supervising the health units in 21 municipalities in the Kathmandu Valley (Figure 1) on the amount and quantity of vaccine waste being stored at the respective vaccination sites.

FIGURE 1

Municipalities contacted in Kathmandu Valley



Step 2 — Develop an activity plan. Based on the findings from the site visits, a plan of activities to optimize waste management in Kathmandu Valley was drafted, with the main components described below.

Step 3 — Set standards. Standard Operating Procedures (SOPs) for the safe collection of vaccine waste in biohazard containers were drafted, a simulation exercise using fake waste (unused syringes and safety boxes) was conducted, and the SOPs were revised in line with the feedback received during the exercise.

Step 4 — Secure storage and disposal sites, and equipment. A warehouse located near a hospital selected for the treatment of vaccine waste had a waste treatment centre and low public access. This hospital was **identified** as a **suitable location** for the **safe storage** of all waste collected from the vaccination sites.

As per the national guidelines on healthcare waste management, the collected vaccine waste had to be disposed of through a waste management system based on non-burn technology. The capacity for fully-fledged waste treatment facilities able to safely dispose of the collected vaccine waste was explored and four hospitals (the Civil Service Hospital, the Nepal APF Hospital, the Paropakar Maternity and Women's Hospital, and the Sukraraj Tropical and Infectious Disease Hospital) were **identified for the safe disposal** of the collected waste.

To accomplish the planned activities, PPE and other equipment to ensure safety and minimize risks such as bio-hazard containers, long forceps and sanitizers were acquired. Additionally, microbiological indicators with incubators, chemical indicators, and autoclave tape were used to ensure the effective use of the autoclaves for each batch of waste. Equipment, such as incubators, were provided, and stands with needle cutters and labels identifying the contents of the bio-hazard containers were specially designed by HECAF360. The labels had a unique code so that the vaccine waste being collected could be tracked, and special instructions were included that restricted the handling of the containers by unauthorized personnel.

Step 5 — Coordinate. Letters to facilitate the **coordination** between vaccination sites, municipalities and hospitals were provided by the Family Welfare Division, Department of Health Services, MoHP to the proposed hospitals. A **schedule and route plan** to collect and transport the vaccine waste from the vaccination sites in the 21 municipalities was developed.

Step 6 — Conduct a simulation exercise and assess health worker knowledge and practice. Lastly, a **simulation exercise** using fake waste was conducted going through all the steps in sequence and the SOPs were revised based on the feedback received.

2. IMPLEMENTATION

According to the schedule, the persons responsible for waste management in the municipalities and vaccination sites were contacted, and based on the information they provided, the estimated number of safety boxes, biohazard containers, and route plans for transporting to storage and treatment sites were calculated. It was estimated that vaccine waste contents from a total of 3,351 safety boxes were to be collected and transferred into the biohazard containers during the pilot phase which was conducted from July 2021 through November 2021. These were then transported to the warehouse for safe storage until the arrangements with the designated health care facilities with waste management systems based on non-incineration treatment were finalized.

For the disinfection and disposal of the sharps, two methods were identified: (i) microwave with shreeder; and (ii) autoclaving of the syringes followed by removal of the needles using needle cutters.

The microwave with shredder method was available at the Civil Service Hospital. This technology can process 20 kg of mixed waste (i.e., paper, plastic, glass, needles and some pathological waste from the hospital) in a single cycle. The waste is ground and sterilized reducing it to inert matter which is then disposed of safely.

The autoclave method was available at the Paropkar Maternity and Women's Hospital. Ideally, the needles should be cut at the vaccination sites and sent for autoclaving to minimize the risk to those handling them. However, as needle cutters were not available at the vaccination sites, the syringes with the needles were shipped in safety boxes for disposal. Since many safety boxes were open and to facilitate autoclaving, the syringes were emptied into puncture-resistant drums by personnel with protective equipment and the drums were then autoclaved. As part of the site visits, the process of autoclaving the waste was very carefully monitored by the technical staff of the WHO Country Office Nepal, and only when the test results were a "pass" (based on examination of the chemical and biological indicators used) was the process considered complete. The decontaminated syringes were then processed using needle cutters to render them unusable and enable the recycling of the plastic. Throughout the process, the WHO CO carried out inspection visits to ensure that correct procedures were being followed and that the personnel responsible for the collection, transport, and treatment of the waste were doing so in a safe fashion.

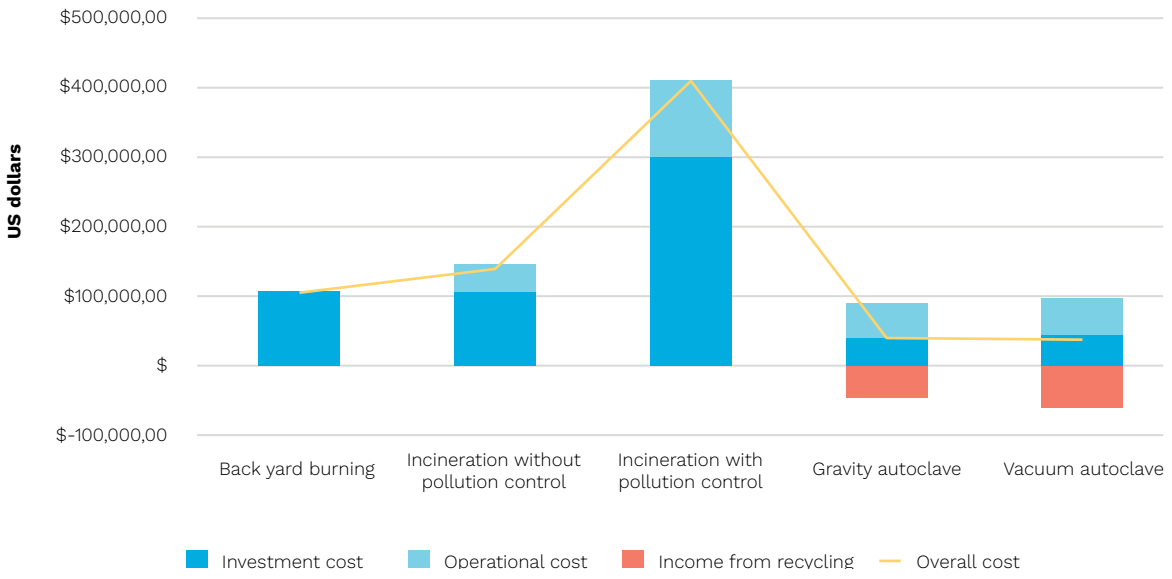
Outcomes

IMPACT

The impact of using non-burning methods of waste disposal has the benefits of reducing environmental pollution and possible cost benefit through income generation from the recyclable material that is made available through autoclaving (Figure 2).

FIGURE 2

Climate benefit: costs over 5 years



Source: Stringer (2013) Grand Challenges Explorations, Interim Report on Safe and Environmentally friendly treatment and disposal of immunization waste

BENEFITS

Vaccine waste (3,361 safety boxes) collected in various vaccination sites operating in the Kathmandu valley was safely collected, transferred, disinfected, and disposed of under this pilot project. The collected vaccine waste was stored in a warehouse until an agreement with the hospital capable of managing healthcare waste was reached. The collected vaccine waste was treated and disposed of via two non-burn technologies - microwave with shredder and pre-vacuum autoclave.

All the recyclable items were recovered after achieving proper disinfection of the waste and mutilation of the syringes was ensured before handing them over to the scrap dealer. Even though, the cost recovered via recycling was negligible the quantity of waste ending at the landfill site was reduced.

CHALLENGES

Disposing of waste via the microwave with shredder methodology was very quick and easy. Waste items such as paper and plastic were turned into unrecognizable municipal waste which could then be disposed of through the municipal waste collection services. However, the waste generated is not suitable for recycling.

Disinfecting the vaccine waste in a pre-vacuum autoclave 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).

Ideally, needle-cutting should happen at the immunization sites. However, the system had not been set up at the time of the pilot study and needle cutters were not available at the vaccination sites therefore the syringes with their needles still attached needed to be transported in safety boxes for disposal.

Some vaccine doses were in pre-filled glass syringes which could not be recycled.

While revenue can be generated by recycling the decontaminated plastic syringes, the revenue generated did not cover the operational costs for autoclaving and additional financing was required. Associated risks to the waste handler existed in both methods. Emptying the contents of the safety boxes increased the risk to the waste handlers. It is preferable to autoclave the safety boxes without emptying the contents into a drum for autoclaving. In this case, since several of the safety boxes were already open, the safer option was to empty the syringes into drums while providing the handlers with protective equipment.

Opportunities beyond the COVID-19 vaccine response

The activities described above demonstrate that a fully functioning healthcare waste management system with segregation of infectious and non-infectious waste can be implemented in all vaccination sites to reduce environmental pollution from healthcare waste. If the use of needle cutters is selected as an option, before their implementation, countries should consider: (a) developing Standard Operating Procedures (SOPs) for the safe use of the equipment and the disposal of cut needles; (b) conducting training for users in the implementation of the SOPs; and (c) providing monitoring and supervision to ensure that the SOPs are adhered to.

However, before procuring and installing needle cutters at health facilities throughout the country, it is advisable to ensure that adequate quantities of safety boxes are procured and that health workers are trained in the appropriate use, storage, treat and disposal of. The relative costs and benefits of using needle cutters should be weighed against those of discarding syringes without removal of the needles into safety boxes but ensuring their proper use. If safety boxes are appropriately used, the boxes can be autoclaved without emptying them, thereby reducing risks.

If onsite waste treatment is not possible, waste should be moved to facilities with fully functioning waste management facilities that can disinfect and dispose of.

To ensure the long-term maintenance of the waste management system in the vaccination sites, the capacity of staff to manage healthcare waste needs to be built, equipment that is not functional should be replaced, and regular feedback on implementation challenges is key.

Lessons

In light of the large quantity of filled (and over-filled) safety boxes being improperly stored, facilities should consider identifying a secured, locked storage place for storing full safety boxes, as well as promoting the good practice of not over-filling safety boxes. Safety boxes usually have the capacity for between 100 and 150 syringes and can then be properly closed and sealed. Overfilling them prevents them from being properly closed and increases the risk of needle stick injury.

Disposing of waste via microwave with a shredder was very quick and easy. While the waste items such as paper and plastic were turned into unrecognizable municipal waste, recycling after disinfection of the waste was not possible.

While disinfecting the vaccine waste in a pre-vacuum autoclave without a shredder takes a longer time, seems more sustainable during routine vaccination as all the recyclable items were recovered after achieving proper disinfection of the waste. Mutilation of syringes was ensured before handing them over to the scrap dealer to prevent reuse. Even though the cost recovered via recycling was negligible, waste ending at the landfill site was reduced. However, microwave with shreeder may be much useful during emergency and mass immunization like in COVID-19.

Associated risks to the waste handler could have been reduced by autoclaving the syringes in the safety boxes without emptying them into a drum for autoclaving or by using the needle cutter to remove the needle before disposing of the syringes. The risk could have also been minimized by providing needle cutters that met recommended specifications to the vaccination sites to remove the needles before disposal of the syringes after ensuring that health workers received adequate training for their use.

Resources

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Information on WHO Nepal and HECAF360 can be found on their websites:

WHO Nepal: https://www.who.int/nepal
HECAF360: www.hecaf360.org

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