A HealthTech Report

Field Evaluation of the Acceptability and Feasibility of Syringe Melters in Indonesia

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Table of Contents

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Executive Summary

In September–December 2006, PATH conducted a field evaluation of three syringe melters temporarily placed in five health centers in Kulon Progo District, Yogyakarta, Indonesia.

During the three-month evaluation, the five participating health centers did not send their sharps waste from immunization activities to the regional incinerator. Instead, immunization sharps waste was handled at the health centers using a syringe melter. The facilities returned to their usual waste management practices at the completion of the evaluation period.

Each of the three melters disposes of needles and syringes through melting the plastic syringe barrels, thereby sterilizing and encapsulating the needles. The purpose of the evaluation was to assess the field performance of the devices, acceptability by health workers, fit into the existing waste management system, and potential design modifications.

In general, participants found the melters easy to use and maintain, practical for managing small volumes of sharps waste, and low cost to operate. They were most concerned by the amount of smoke the melters generated, the low volume of syringes they were capable of melting in one cycle, and the use of dirty or charred syringe containers at points of injection. Unintended use of the stovetop melter highlighted some potential safety concerns that could similarly be found with any syringe melter.

The syringe melters were thought to be most applicable in health centers with decentralized waste management systems where the volume of syringe waste is relatively low and there is no access to an incinerator. In addition, users felt the melted blocks could be sent or sold to plastics recyclers if the melter was used in conjunction with a needle remover.

This evaluation demonstrated that while feasible, the introduction of syringe melting into an existing health care waste management system may require shifts in current waste management practices. In addition, an acceptable melter design would need to address health worker concerns about safety and appearance and ensure that the melter is not misused. However, there is a potential niche for syringe melting as a method of managing sharps waste in facilities without access to adequate sharps disposal methods and with low volumes of syringe waste.

Further evaluation of syringe melting in other waste management settings is needed, particularly to gauge acceptability and system fit in settings with little or no formal waste management systems in place.

Background

Sharps Waste in Indonesia

In 2003–2004, PATH worked with the Indonesian Ministry of Health (MOH) to model sharps waste management systems in three districts of Yogyakarta province, covering a population of 1,677,000 and 67 health centers. Some potentially harmful sharps waste management practices observed during an initial assessment included:

- Reuse of disposable syringes without proper sterilization.
- Disposal of medical waste through open burning or through municipal waste collection.
- Improper waste segregation—used syringes were disposed of with the domestic waste and/or sold to scavengers.
- Scattered syringes around the health center back yard.

Mapping data led to the creation of two distinct strategies for medical waste handling: a centralized system for urban areas, and a decentralized system for rural areas.

Syringe Melting—Decentralized Management of Sharps Waste

WHO's recommended strategies for sharps waste management in the absence of functioning small-scale incinerators includes research and promotion of new disposal technologies that can provide alternatives to small-scale incineration. A non-incineration waste disposal strategy such as syringe melting may prevent disease burden caused by unsafe handling of sharps waste.

Syringe melters, devices designed to destroy syringes and sterilize needles through melting, are a potential means to safely dispose of syringes after use. Syringe melters can use multiple fuel sources to provide the heat to melt syringes, making them adaptable to a variety of infrastructures. Currently under development are syringe melters that use electric heating elements, solid biomass fuel (e.g., wood or dung), passive solar heating, and gas fuel (e.g., propane). These devices are designed to melt syringes without ignition or burning, thereby reducing the waste volume, disinfecting the syringe materials, and encapsulating the various syringe components including the needle. Syringe melters can be used as a point-of-care, self-contained disposal option, wherein the syringe and needle are dropped into the melting container immediately after use (in place of a safety box); or in conjunction with a needle remover, allowing the syringe barrels to be stored in bins or plastic bags before being melted.

Syringe Melter Assessment in Indonesia

In September–December 2006, PATH conducted a field evaluation of three syringe melters temporarily placed in five health centers in Kulon Progo District, Yogyakarta, Indonesia. Kulon Progo District has a medical waste management system that includes using a regional centralized incineration network as the final disposal method. This system was temporarily modified for the syringe melter evaluation. During the three-month evaluation, the five participating health centers did not include their sharps waste from immunization activities in the regional incineration network. Instead, immunization sharps waste was disposed of at the health centers in

a syringe melter. The facilities returned to their usual waste management practices at the completion of the evaluation period. The three syringe melters evaluated are described below.

New Paradigm Syringe Melter

The New Paradigm melter design comprises a short insulated drum with an insulated lid and handle. The inside of the drum contains a fixture on the bottom to hold a pan of biomass fuel and a fixture on the inside of the lid to hold the syringe container. The melter uses a rectangular pan with a hinged lid and a slot as the syringe container (the lid and slot was a design modification by PATH). This pan, which holds approximately 75, 3-ml syringes, is intended to be used in place of a safety box at the point of injection and then placed into a holding fixture on the inside of the lid of the melter barrel during the syringe melting cycle. The syringe container is intended to be reused by removing the melted plastic block out of the pan after each melt cycle. The melter uses any biomass fuel, such as charcoal, wood, dung, or coconut shells, and is intended for long-term use.

Sigma-K Syringe Melter

The Sigma-K melter is a taller cylinder with open air circulation through the bottom and a lid with handles and a manually operated air vent. Modifications made by PATH before the field evaluation were: modifying the air vent to convert it to manual control, adding stabilizing legs to prevent tipping of the melter on uneven surfaces, adding handles to the melter lid, and adding a lid with a syringe insertion hole to the syringe container. The syringe container, which holds approximately 150, 3-ml syringes, is intended to be used in place of a safety box at the point of injection and then placed into the melter barrel to melt the syringes. It is intended to be reused by removing the melted plastic block out of the can after each melt cycle. The melter can use any biomass fuel, such as charcoal, wood, dung, or coconut shells, and is intended for long-term use.

Spanner Stovetop Melter

The Spanner Stovetop melter has several features that are different from the other two melters, including fuel source (gas or electric instead of biomass), the addition of a filter to permit indoor use, and the reutilization of the syringe container without emptying between melting cycles. For the syringe container, the melter uses a modified paint can, outfitted with a charcoal filter attached to the lid and a hole (with plug) in the lid for inserting used syringes. This can is intended to

be used in place of a safety box at the point of injection and then placed on a gas or electric burner/stovetop to melt the syringes. It is intended to remain sealed through several melt cycles so that previously melted plastic is remelted when processing newly added syringes. Once full, the entire can, with melted plastic block enclosed, is intended for disposal in medical or municipal waste streams.

Assessment Design and Objectives

Prior to shipping to Indonesia, the melter prototypes underwent a short operational assessment at PATH in Seattle to confirm basic function and safety. PATH study coordinators also submitted the evaluation protocol to the PATH research determination committee and received a determination that the evaluation was not considered research on human subjects according to United States federal guidelines. At the start of the field evaluation, participating health workers—managers, head nurses, injection providers, and waste handlers—took part in a one-day seminar during which they received refresher training in injection safety, discussed issues related to use of the melters in their facilities, and were trained in the use of the syringe melters. The melters were then installed at each health center, refresher training was provided as needed, and the health center was supplied with a full set of personal protective equipment appropriate to the activity: face mask, goggles, apron, long gloves, and boots. PATH Indonesia study coordinators conducted a monitoring visit to each facility mid-study to assess compliance with correct use, safety, and data collection. Following the evaluation, representatives from each participating facility assembled again to present specific results from each facility, discuss general results of the evaluation, impressions of each melter, and next steps for PATH and the MOH.

The primary objective of this assessment was to collect preliminary performance and acceptability data on the syringe melter from health managers and health workers in Indonesia to inform future investment and product design. A secondary objective was to evaluate the fit of this device within the existing waste management system. Evaluation criteria included:

- **Training**: Methods and number of training sessions required for participants to correctly and independently operate a syringe melter.
- **Ease of use**: Ability of health care workers to use the devices correctly and consistently, problems associated with use of the device, consistency of correct use.
- **Acceptability**: Acceptability of the melter among health workers and waste disposal personnel.
- **Performance**: Time required for syringes to completely melt, energy requirements of melters, operational failures, and maintenance requirements.
- **System fit**: Fit of the melter within the existing Indonesian waste management systems, including final disposal options.

Qualitative data on acceptability of the syringe melters were obtained during health center trainings (when melters were installed), simulated use during the pre-evaluation training seminar, pre- and post-evaluation discussions with health workers, and reported outcomes of device use during the three-month field evaluation. These data assessed the melters' ease of operation, ease of maintenance, acceptability to operator, perception of safety, acceptability of resulting waste,

and recommendations for final disposal of melted waste. Quantitative data on device performance and function were collected in data collection forms and compiled weekly.

Results

New Paradigm Syringe Melter

The New Paradigm Syringe Melter functioned well throughout the course of the evaluation. It was run through 10 melt cycles, processed approximately 82 syringes per cycle, and averaged 84 minutes per cycle. Users noted that there were no problems with any of the melter components during the evaluation and that the only maintenance needed consisted of cleaning the syringe containers after use during melting before placing them at each injection station. Participants initially used cardboard for fuel but switched to coconut shells because they burned at a higher temperature.

Overall, the assessment participants found the New Paradigm Syringe Melter to be easy to use and practical. They felt it would be most efficient in low syringe-volume settings such as smaller facilities and those without access to a centralized incineration facility, and suggested that during mass-immunization campaigns an alternative procedure for processing sharps waste would be needed. While they felt that incorporating the melter into their existing waste management system added some additional workload, it was not substantial and could be done in conjunction with other tasks. They noted that it was easy to maintain and inexpensive to operate, calculating that the fuel needed to run it cost approximately US$0.08 per cycle.

The assessment participants did have some concerns about the melter, most notably that it produced heavy smoke and fumes. They also felt the melting container was too small to process high volumes of syringes during immunization campaigns and were concerned that needles protruding from the melted block heightened the waste handler's risk of needlestick injury. Finally, the participants felt that with the encapsulated needles the melted blocks would be difficult to dispose and could pose a needlestick threat to the community. However, they commented on the potential of the melted blocks to be disposed of through plastics recycling if the melter were used in conjunction with a needle remover. The idea of sending or selling the melted block to plastic recyclers was appealing to them.



Recommendations

There were several recommendations for modifying the design of the melter, including making the melting pan larger, installing a hatch in the side of the melter barrel to load fuel, and adding a chimney to draw smoke and fumes away from the user. Participants also recommended using the melter in conjunction with needle removal to encourage recycling of the melted plastic block. Finally, they noted that to effectively and safely manage sharps waste, melting pans would need to be sufficiently durable and low in cost to allow for one pan at every injection station.

Sigma-K Syringe Melter

The Sigma-K Syringe Melter functioned well throughout the course of the evaluation. It was run through 10 melt cycles, processed a total of 915 syringes, and averaged 30 minutes per cycle. Users noted that the fuel for the melter was inexpensive and easy to obtain and that the only maintenance needed consisted of cleaning the fuel ashes out of the melter drum, to maintain sufficient air flow. However, it generated considerable smoke and fumes.

The assessment participants found the melter easy to use. Although incorporating the Sigma-K Syringe Melter into the existing waste management system added some additional workload, it could be run while the operator performed other tasks. However, in addition to the considerable smoke generated, participants found it difficult to remove the melted block from the syringe container, and, when hot, it was difficult to insert the syringe container and to fit the lid on the melter drum. They also had several concerns about the fit of the melter within the existing waste management system. They felt that that needles protruding from the melted block added risk of needlestick injury and that the unique shape of the blocks might attract children's interest if left out. They also noted that melter containers would need to be supplied in sufficient quantities and low enough in cost to allow for one pan at every injection station to prevent health workers from transferring the needles and syringes from safety boxes to the melter container.

The participants thought the melter would be most applicable in low syringe-volume settings, such as in rural health centers or facilities that currently do not have a sharps disposal system in place (the Wates health center normally sends its sharps waste to a centralized incinerator). They noted that the melted blocks were not appropriate for disposal in the municipal waste stream and commented on the potential of the melted blocks to be disposed of through plastics recycling. Sending (or selling) the melted block to plastic recyclers was appealing to them, but would require that the needles be removed prior to melting the syringes.



Recommendations

To mitigate exposure to the smoke and fumes generated by the melter, participants suggested adding a chimney or filter to the vent. They also commented that a handle on the syringe container would make it easier to insert and remove the syringe container, particularly when the melter is hot, and that the syringe container could be more conical to make it easier to knock the melted block out of the container. Finally, they thought the syringe container could be made smaller so that the melter could accommodate several containers during one melt cycle.

To address concerns related to disposing of the melted block, participants suggested that a sieve could be installed in the syringe container to separate the needles from the melted plastic. This would enable the plastic block to be recycled. Another approach also suggested would be to use a needle remover in conjunction with the syringe melter.

Spanner Stovetop Melter

The three Spanner Stovetop Melters that were evaluated functioned well, averaging about 30 minutes per melt cycle and processing 150–200 syringes per cycle. The three melters were collectively run through 33 melt cycles (number varied depending on facility). The assessment participants found the melters easy to use and the training simple to understand. However, it should be noted that the melters were not used as intended, resulting in the early cessation of the assessment of the Spanner Stovetop Melters.

Instead of dropping the syringes directly into the melter can (in place of a safety box), health workers using the Spanner Stovetop Melters collected the syringes in safety boxes and then emptied them into the melter cans. One reason given for using the melters in this manner was that participants were not supplied with enough melter cans to place one at each injection station, and that doing so would not generate high enough syringe waste volume to run the melter regularly. They also felt that the cans, which became distorted and corroded with repeated use, did not appear clean and therefore made them undesirable additions to their injection stations. In addition, instead of adding syringes to the cans and remelting the contents each time the can filled up, users opened the cans after each melt cycle and pried the blocks loose. They then stored or buried the blocks on site.

Based on this modified use, health workers were concerned about the risk of needlestick injury from needle snags protruding from the blocks. They also indicated that using the melters as intended would continuously increase the amount of fuel and time needed to remelt the existing plastic in the can during each new melt cycle—an undesirable feature. Finally, all users expressed concern about the noxious fumes emitted by the melters, which was unanimously considered a major deterrent to using the melters.

Although the assessment participants felt that adding the melters into their existing waste management system added some additional workload, they felt it was not substantial and did not interfere with their work. Participants also commented on the low cost of fuel for one melt cycle (this cost would increase if the melter were used as intended and run through multiple melt cycles) and the potential of the melted blocks to be disposed of through plastics recycling. They pointed out that this would only be possible if the melter was used in conjunction with a needle remover. Finally, they thought that the melters would be most appropriate for health centers with low volumes of syringe waste and those located far from an incineration facility.

Recommendations

While adequate training is an essential component to compliance with proper melter operation, the melter should be designed such that it is difficult to use by any method other than as intended, perhaps by having an integrated or welded lid that would prevent removal by the user. While this would prevent inappropriate use, it does not address participants' concerns related to fuel requirements. More study will be required to determine the optimal number of melting cycles to recommend to users before discarding the partially filled melter and whether a discolored can could be made acceptable to users for placement at injection stations.

Discussion

User Acceptability

The evaluation participants felt that syringe melters could be an acceptable means of managing injection waste in settings with low volumes of syringe waste or in facilities without access to a centralized disposal system, such as rural health centers. They found the melters easy to use and maintain, practical, and low cost to operate.

Participant comments common to all three melters included:

- **Smoke and fumes**— If syringe melting is to become a viable alternative to incineration, further testing of emissions from several syringe melter designs will be necessary to ensure that syringe melters produce fewer hazardous emissions than a properly functioning incinerator.
- **Melter size**—Users in all three evaluations felt that the volume of syringes able to be processed in one melt cycle would not be sufficient during mass immunization campaigns or in high injection-capacity settings.
- **Container accessibility**— Syringe containers would need to be durable, low in cost, and available in sufficient quantities to ensure that one would be placed at each injection location.
- **Appearance**—Some users commented on the charring and discoloration after running the syringe containers through several cycles and noted that the corroded appearance could be a deterrent to health workers keeping the syringe containers at the injection stations.
- **Final disposal**—All evaluation participants noted that they had been given no instructions on how to dispose of the melted plastic blocks. They were concerned about

risk of needlestick injury when disposing of the blocks in municipal waste or other nonmedical waste streams because of the needle stubs poking out of the plastic blocks. In all three evaluations, participants suggested separating the needles from the syringes and sending or selling the melted plastic blocks to a plastics recycler.

Having had a waste management infrastructure already in place may have affected how the participants used the syringe melters as well as their perception of the melters' acceptability and functionality. For example, introducing the melters into their existing waste management system added some additional workload due to the need to separate the immunization waste from all other sharps waste. In addition, the prototype melters had some functional challenges which, compared to their usual waste management procedure of centralized incineration, may have influenced how the participants perceived the overall system fit of the melters. Again, evaluation of syringe melting in other waste management scenarios might offer additional insight into the potential system fit of these devices.

Misuse of Syringe Melters

As noted in the Results section for the Spanner Stovetop Melter, potentially dangerous misuse of syringe melters can occur if the syringe containers are not used in place of a standard safety box and, instead, syringes and needles are transferred from safety boxes to the syringe melting container. This misuse can be further complicated if safety boxes are commonly used for disposal of other injection materials (e.g. cotton, vials) that are not appropriate for inclusion in the melter. Alleviation of this type of problem will require both quality and consistency in training and an emphasis placed on the proper handling of sharps waste after injections.

Follow-up Questions

Several questions related to user acceptability of syringe melting remain:

- How would syringe melting be received by health workers in a facility with minimal waste management systems in place? How would melting be received in a facility that currently does not segregate sharps waste from infectious waste (or one that does not segregate waste at all)?
- If reasonable modifications do not fully mitigate emission of smoke and fumes would the melter be acceptable to users?
- If sufficient quantities of the syringe container are available, would users accept a charred or otherwise visually unpleasant can as a safety box for use at an injection site?
- Can the syringe container be designed to lock or otherwise ensure that syringes are not handled, reused, or spilled prior to melting?
- Would syringe melting be acceptable and practical if combined with needle removal and integrated into a plastics recycling system?
- If mass immunization campaigns generate too many syringes to be practically disposed of using a syringe melter, will separate disposal options for campaigns and routine injections create confusion, extra expense, or otherwise be unacceptable to users?

Conclusion

This evaluation demonstrated that while feasible, the introduction of syringe melting into an existing health care waste management system may require shifts in current waste management practices. In addition, an appropriate melter would need to address health worker concerns about safety and appearance and ensure that the melter is not misused. However, there is a potential niche for syringe melting as a method of managing sharps waste in facilities without access to adequate sharps disposal methods and with low volumes of syringe waste. Further evaluation of syringe melting in other waste management settings is needed, particularly to gauge acceptability and system fit in settings with little or no formal waste management systems in place.

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