

Medical Waste Management for Primary Health Centers in Indonesia

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Executive Summary

This 18-month project sought to model effective options for management of medical waste for health centers in Indonesia. Three districts, representing two different levels of infrastructure, were selected in one province on the main island of Java.

Eight steps were undertaken to create locally appropriate waste management solutions:

1. Raised awareness of issues in medical waste management.
2. Conducted a situational analysis—mapping and assessing of capacity and infrastructure.
3. Designed and implemented pilot waste management strategies.
4. Trained personnel.
5. Introduced safety boxes for needle and syringe disposal after all injections.
6. Utilized existing incinerators where available, installed small-scale incinerators where needed.
7. Conducted supervision and observations.
8. Built upon lessons learned.

One of two different approaches was implemented in each district, depending on the infrastructure and population density of the district:

Centralized system for urban areas

In urban areas a centralized approach focused on regular collection of infectious waste from the health centers with transport to and incineration at an existing hospital incinerator. The critical components were a motorcycle with bins for waste collection, an agreement with the hospital to incinerate the waste, and technical assistance for capital improvements to the hospital incinerator to reduce emissions.

Decentralized system for rural areas

In rural areas a decentralized approach involved installing small-scale incinerators in centrally located health centers so that they could be used as incineration hubs for local health facilities within a 12-km radius. Safety boxes were transported to the incinerators during routine trips.

For both the urban and rural approaches, the new medical waste management systems provided effective solutions at a cost of approximately US\$18-\$28 per health center per month (Appendix A). Segregation and use of safety boxes, combined with waste transport and destruction systems, eliminated infectious waste discarded in health center yards or into municipal waste.

- Urban—The urban approach was especially successful since it required less capital input and a simple transport system. It cost approximately \$2 per kilogram of infectious waste and became locally sustainable after the project ended when the district government agreed to fund the waste collection and incineration costs.
- Rural—The rural system had higher costs to install the incinerators and a low volume of sharps waste reaching the incinerators, resulting in costs of approximately \$6-\$9 per kilogram of sharps waste. The small-scale incinerators worked effectively in treating the sharps waste without causing environmental problems. Reliable transport without dedicated vehicles remained a challenge in this approach especially for more remote health centers. A locally produced mini-incinerator offered potential for waste destruction without transport for remote sites.

Introduction

Indonesia's current medical waste policy covers only hospitals and clinical laboratories. There is a need to establish similar standards and procedures of waste management at the health center level. With the introduction of autodisable syringes for immunization, the issue of health center medical waste management is increasingly significant.

During 2003–2004, PATH, working with the Indonesian Ministry of Health, undertook a process of awareness building and modeling to provide policy guidance to Indonesia's decision-makers. Pilot waste management systems were implemented in three districts of Yogyakarta province, covering a population of 1,677,000 and 67 health centers. These areas contained both rural and urban populations, infrastructures, and physical conditions that were considered representative of many districts in Indonesia.

This report describes the process conducted in Indonesia and the lessons learned. It is being used to guide waste management policy development in Indonesia and could provide a useful model for other countries.

Step One: Raising awareness of issues in medical waste management

A national workshop was held in mid-2003 to raise awareness of the significance of medical waste management. The workshop was attended by national government personnel involved in immunization and environment issues, MOH representatives from each province, international organizations, donor agencies, and local manufacturers of waste disposal devices. Waste management issues and problems were discussed, and possible approaches to solving the problems were presented.

The meeting resulted in several key outcomes:

- The establishment of a national committee on medical waste management.
- Heightened awareness of the issues, options, costs and commitment required.
- Agreement to collaborate among various sectors of the government.
- A call for more information about practical approaches to waste management for health centers, resulting in an agreement to model different options in Yogyakarta.

Throughout the implementation of the project, presentations and debriefings were made to the local government and health offices. In Indonesia's newly decentralized system, these groups have wide-ranging decision-making and budgeting authority over health centers in their districts. Medical waste issues and the project's progress in overcoming these issues were brought to their attention as often as possible. Involving local government proved its value at the end of the project when the Yogyakarta municipal district government agreed to fund all costs for continuing the project in the city. This included incineration fees, labor costs for waste pick-up, and provision of a vehicle for waste collection.

Step 2: Situational analysis—mapping and assessing of capacity and infrastructure

Mapping and assessment was conducted in the three selected districts. Mapping provided basic data on the relative locations of health centers, existing incinerators, the road system, and patient

volume and injection quantities at each health center. This information was critical in designing waste collection and disposal systems that matched the physical constraints of the districts. Mapping and assessment data heightened awareness of the specific problems and provided a strong impetus for developing practical waste management models. Some practices observed during the assessment process included:

- Reuse of disposable syringes without proper sterilization.
- Recapping of used injection devices prior to disposal.
- 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.
- In rural areas, disposal of medical waste through open burning.
- In urban areas, disposal of medical waste through domestic waste service.

Step 3: Design and implementation of pilot waste management strategies

A series of discussions was held between PATH and district, provincial, and national MOH representatives to develop realistic and appropriate options for implementing the pilot waste management strategies. Analysis of the mapping and assessment 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.

Centralized system for urban areas

A centralized system of collection and transport of health center medical waste to a nearby hospital incinerator was designed for the urban areas of Yogyakarta municipality.

The design of the system was based on the following considerations:

- Existing high-temperature incinerators available at nearby hospitals.
- Short transport distances (<6 km) between health centers and available incinerators.
- Unfeasible to bury or burn medical waste at health centers.

The primary components of the centralized waste management system included:

- Waste segregation—All health center waste was segregated into three containers at the point of use:
 1. Sharps (using safety boxes).
 2. Infectious waste (using white or yellow plastic bags in plastic tubs).
 3. Noninfectious waste (using black plastic bags or standard waste bins).



- Waste transport—Filled safety boxes and bags of infectious waste were collected twice a week from each of the 18 urban health centers. A motorcycle, fitted with a rack to hold plastic tubs, was used by a district health worker to collect sharps and infectious waste according to a set schedule each day.
- Incineration at a large-scale hospital incinerator—Each day the waste was delivered to one of the public hospitals for incineration.
- Collection of noninfectious waste—Noninfectious waste was collected each day by the municipal garbage service.

The required financial inputs of the centralized waste management system follow (complete analysis provided in Appendix A):

- Incineration fee: \$0.50 per 1 kg waste.
- Incinerator repair: The hospital incinerator was functional but needed major improvements to optimize operation. Improvements, which were estimated to cost \$5,000, were not conducted. Instead, the hospital committed to installing a new incineration system with larger capacity and better performance.
- Transport: Cost of motorcycle rack and bins, payment to motorcycle driver for fuel and maintenance, and use of motorcycle.
- Health staff payments: Incentives to waste collection staff at health centers.
- Monitoring: Payments to supervisors and reimbursements for attendance at evaluation meetings.

Decentralized system for rural areas

A decentralized system for local disposal of health center medical waste was designed for the semirural and rural areas (20 and 29 health centers respectively).

The design of the system was based on the following considerations:

- Long transport distances between health centers and existing incinerators (>12 km or >60 min drive).
- Unfeasible to transport waste to a single central location due to staff and transport limitations.
- Land available at most health centers for incineration, burning, and/or burying of waste.

The primary components of the decentralized system of waste management included:

- Waste segregation—All health center waste was segregated into three containers at the point of use:
 1. Sharps (using safety boxes—a routine resupply of safety boxes for disposal of all syringes was established).
 2. Infectious waste (using white or yellow plastic bags in plastic tubs).
 3. Noninfectious waste (using black plastic bags or standard waste bins).
- Small-scale incineration—Small-scale incinerators were installed at three to five hub locations within each district. Health centers were organized into incineration clusters

that would transport medical waste to the nearest small-scale incinerator. In some cases only sharps boxes were taken to incinerators; in other cases both sharps and infectious medical waste were incinerated. Noninfectious waste was typically dumped in shallow pits and burned at each health center.

The required financial inputs of the decentralized waste management system follow (complete analysis provided in Appendix A):

- Incineration fee: \$0.20 per 1 kg waste.
- Incinerator installation—Small-scale incinerators were purchased and installed.
- Incinerator operator protection—Incinerator operators were supplied with protective clothing.
- Incinerator operator payments: Incentives to operators at incineration hubs.
- Transport: Additional funding was not provided for transport—routine trips were used to transport waste.
- Monitoring: Payments to supervisors and reimbursements for attendance at evaluation meetings.

Step 4: Training of personnel

Training for all health center staff and district supervisors was conducted in each district. Key training components included:

- Injection safety review.
- Procedures for centralized and decentralized systems.
- Use of technologies: safety boxes, needle removers, incinerators.

Step 5: Introduction of safety boxes for needle and syringe disposal after all injections

At the start of the project, only the Expanded Programme on Immunization provided safety boxes for disposal of immunization syringes. The project purchased safety boxes in sufficient quantities for all health center injections. Safety boxes were located at each injection station and provided to sub-health centers and outreach teams. A typical health center used one to two safety boxes per month.

Since injection volume was very low in most sub-health centers, and to encourage outreach workers to carry safety boxes on outreach, 0.5-liter safety boxes were also provided. These boxes were manufactured by an Indonesian safety box producer using World Health Organization (WHO) standards for the 5-liter boxes as a guide. The smaller-size boxes were preferred by outreach workers and appreciated in health centers where large boxes would have taken more than a month to fill.

Step 6: Installation and use of small-scale incinerators in rural areas

To compare the performance of different small-scale incinerators, four different types of incinerators were built and/or installed. All use biomass as fuel. Two were developed by a local

nongovernmental organization (NGO) and refined with project funding. In all cases, the health centers with the incinerators charged a fee of about \$.20 per kg of waste incinerated to cover fuel costs and operator fees. An informal cost analysis suggested that a fee of \$1.00 per safety box (or kg) of waste would cover incinerator operating and maintenance costs.

One health center employee at each incinerator location was designated as the incinerator operator and trained by the incinerator manufacturer or builder.

The feasibility of transporting waste to the incinerators was related to the distance to the incinerator. Where the incinerator was within 6 km, waste was transported regularly. When distances were between 6 and 12 km, health centers tended to accumulate at least four to six safety boxes before transporting them to the incineration facility. In general, a transport distance greater than 12 km resulted in unreliable transport of waste.

The four different small-scale incinerators used were:

DD-Best—The DD-Best was designed by a local NGO and is marketed in Indonesia. It is used by surrounding health centers as well as a number of private medical providers. The main fuel used is wood or coconut husks. The incinerator is considered easy to use and maintain. The incineration service is expected to be an income-generating activity for the health center.

De Montfort—Following WHO-provided plans, a De Montfort Mark 8a incinerator was built on site at one health center. Experimentation with different loading procedures found optimal performance with 20 to 30 minutes preheating and periodic waste loading approximately every 20 minutes. Skilled construction, proper materials, a well-trained operator, and regular maintenance were considered vital to the optimal performance of this incinerator.

SICIM—A SICIM incinerator was purchased from its manufacturer in Italy and installed. The design of the SICIM is such that a single batch must be loaded and incinerated and then allowed to cool before another batch can be loaded. SICIM was the only incinerator tested that did not consistently meet the minimum operating temperature of 850°C which defines medium temperature combustion.

DD-mini—The DD-mini was designed by a local NGO for small waste volumes. Its combustion chamber fits a load of fuel and a single safety box. Wood, peanut shells, and rice husks were all acceptable fuels for the DD-mini. After a 20 minute warm up period, disposal boxes could be incinerated at 30 minute intervals. The incinerator was considered easy to use and maintain.



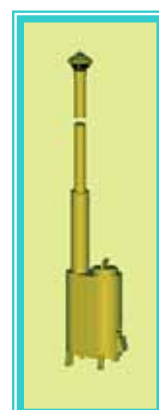
PATH **DD-Best**
October 2005



De Montfort Mark 8a



SICIM



DD-Mini

Incinerators Installed in Project Districts

No. used	Incinerator	# of Health Centers served	Approximate incineration frequency	Technical details
1	DD-Best	11	± 1/week	Manufactured locally by Yayasan Dian Desa Fuel: biomass Continuous feed Capacity: 35 kg/hr Dimension: 740 x 1080 x 1820 mm Price: \$3,333
1	De Montfort Mark 8a	14	1/2 weeks	Locally built based on design from De Montfort University, UK/WHO Fuel: biomass Continuous feed Capacity: 12 kg/hr Dimension: 1200 x 480 x 950 mm Price: \$2,750
1	SICIM	9	1/month	Imported from Italy Fuel: biomass Batch feed Capacity: 40 kg/hr Dimension: 2500 X 1200 mm Price: \$4,500
3	DD-Mini	3	1-3/week	Manufactured locally by Yayasan Dian Desa Fuel: biomass Continuous feed Capacity: 2 kg / hr Dimension: 520 x 320 x 700 mm Price: \$666

Temperatures, emissions, and ash composition were measured for each incinerator. Two of the hospital incinerators were tested for comparison. Technical data are summarized below.

No	Incinerator	Temperature (°C)		Emission			Ash composition*		
		1° chamber	2° chamber	CO (ppm)	O ₂ (%)	CO ₂ (%)	Pb (mg/l)	Cd (mg/l)	Cu (mg/l)
1	Hospital incinerator 1	700–1000	± 400	Not conducted			Not conducted		
2	DD-Best	800–1300	900–1000	2–400	3–13	6–13	Not conducted		
3	Hospital incinerator 2	Not conducted					0.0295	0.0039	0.0057
4	De Montfort	800–900	800–900	Not conducted			Not conducted		
5	SICIM	500–700	N/A	Not conducted			0.0169	Less than detection limit	Less than detection limit
6	DD-Mini	800–1150	800–1250	4–1300	3.3–14.7	4.6–12.9	0.0273–0.0462	0.0030–0.0043	Less than detection limit
Standards/ Recommendations*		540–980 (WHO)	980–1200 (USEPA) >850 (EU) >800 (WHO)	40 (USEPA)					

* Batterman S. *Findings on an Assessment of Small-Scale Incinerators for Health Care Waste*. WHO: Geneva; 2004 (USEPA: United States Environmental Protection Agency; EU: European Union)

Step 7: Supervision and observations

Routine supervision was critical in correcting problems and reinforcing training messages. Observations made during supervision provided an ongoing monitoring tool for evaluating the impact of the project.

The primary focus of supervision for monitoring achieved progress included:

- Needle recapping—Recapping was initially a widespread practice and supervisors encouraged immediate disposal instead of recapping.
 - Progress—Recapping decreased during the project but persisted among some health workers.
- Use of safety boxes—Initial problems with improper assembly or boxes not being located at each injection station were quickly overcome.
 - Progress—Syringes scattered around health centers were eliminated. Use of safety boxes during outreach increased.

- Waste segregation—Segregation practices were initially inconsistent and proper procedures were reinforced during supervision.
 - Progress—All facilities were performing adequate segregation.
- Waste transport to incinerators—Initial barriers included lack of a vehicle, lack of funds, and lack of motivation. Supervisors were able to identify existing vehicles and suggested using monthly meetings as opportunities that could be used to transport waste to incinerators.
 - Progress—By the end of the project, 75 to 85 percent of the rural health centers were transporting waste to incinerators, with those further than 12 km from the incinerator showing the lowest compliance. In the urban locations, waste pickup and transportation was conducted routinely at all health centers.
- Incinerator operation and maintenance—Supervision by a technical team helped incinerator operators optimize fuel use, loading practices, and ash disposal.
 - Progress—With increased operator experience, levels of smoke were reduced.
 - Problem—One unresolved issue was how to treat capped vials. Although it was recommended that capped vials have their caps removed before incineration, this was slow to implement.
 - Problem—It proved difficult to convince the hospitals who owned the hospital incinerators to conduct repair and maintenance on these units.

Step 8: Building upon lessons learned

Solutions must be situation specific

There is no universal solution to medical waste management. Different situations require different solutions. The process of reviewing each district's physical, demographic, and health infrastructure characteristics will optimize system design. The approaches modeled in Yogyakarta were effective in managing waste.

- *Centralized system for urban areas*—The centralized approach piloted in the project worked well for an urban setting. Routine waste segregation and a well-coordinated waste pickup system are the key challenges within this system.
- *Decentralized system for rural areas*—The decentralized approach worked well in semi-rural and rural settings, but waste transportation to incinerators was a challenge. Organizing a system of small-scale incinerator hubs requires careful planning. Health centers greater than 12 km from the incinerator have more difficulty delivering waste.

Small-scale incineration is feasible

Small-scale incineration can be installed locally and provides an environmentally acceptable and practical method for infectious waste destruction. Four of the five incinerators installed met the definition of medium- or high-temperature incineration recommended by WHO. All were acceptable to the health centers and local communities. To ensure optimal use of small-scale incinerators, several steps must be taken:

- Clear guidelines on their operation and maintenance must be provided and enforced.

- Construction must be high quality.
- Incineration fees should cover operation and maintenance costs as well as depreciation. The study yielded an estimate of \$1.00 per kg waste as an appropriate fee.
- Operator motivation is critical to the successful operation of the incinerator and the marketing of its services.

Transportation is crucial

All incineration-based systems, whether centralized or decentralized, require transportation of sharps waste. Better use of existing vehicles and trips is crucial to a practical transportation strategy.

Sustainability requires collaboration

A great number of people and government agencies will need to work together closely to support a sustainable health center waste management system. Key participants will include:

- Local health officials—The health centers that performed the best in the project were the ones that had the highest levels of support from the health center heads and the district health offices.
- Local government—As witnessed in the Yogyakarta municipal district, involvement of the local government resulted in the provision of all operating costs and a vehicle to continue the pilot system.
- Immunization, waste, and sanitation staff at local and national levels—Sharing the responsibility for waste management results in consistent support and guidelines.

Next steps for Indonesia

- Draft a national policy on medical waste management for health centers.
- Develop national guidelines for appropriate waste disposal approaches, systems, equipment, and personnel responsibilities.
- Disseminate practical guidance to districts to raise awareness, guide local solutions, and outline local funding requirements.
- Conduct research, analysis, and modeling of syringe recycling options.
- Replicate the Yogyakarta project in another region of Indonesia to serve as a regional demonstration model.

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Appendix A—Cost Estimate for Medical Waste Management System Yogyakarta Province, 2004

Details			Approximate cost per month (US\$)		
			Urban district (Yogya City)	Semirural district (Kulon Progo)	Rural district (Gunungkidul)
Monthly operational costs					
Waste collection and transport costs	Motorcycles visit 3 HC/day = average 10 km/day (Yogya City)	±1 L gasoline/day; \$.20/liter	\$4.00		
	Incentive for waste collector (2 staff)		\$68.00		
	Waste transport fee: \$9.00/HC/mo			\$178.00	\$258.00
	Safety box: \$.66/HC/mo		\$12.00	\$13.33	\$19.33
Salary supplement	For incinerator operator		\$16.66	\$16.66	\$16.66
Incineration fee	(Note: incineration fees cover incinerator maintenance)	\$1.00/kg for Yogya city	\$300.00	\$60.00	\$60.00
		\$1.00/kg for SSIs			
Supervision visits + evaluation meeting		\$300/year	\$25.00	\$25.00	\$25.00
Subtotal: monthly operational costs per district			\$425.66	\$292.99	\$378.99
Monthly capital costs			Total cost		
Purchase of motorcycle rack systems (ammortized for 1 yr)		\$67.77	\$5.65	does not use rack	does not use rack
Purchase of incinerator + training, cap. building (amortized for 5 yrs)	Hospital incinerator repair: \$5000		\$83.00		
	DDBest: \$4500; DDMini: \$666			\$86.00	
	DeMontfort: \$2750; SICIM: \$5000, DDMini (2 units): \$1333				\$160.00
Needle pit 3 HC/district (amortized for 10 yrs)		\$55/pit	\$5.50	\$5.50	\$5.50
Subtotal: monthly capital costs per district			\$94.15	\$91.50	\$165.50

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Details		Approximate cost per month (US\$)		
		Urban district (Yogya City)	Semirural district (Kulon Progo)	Rural district (Gunungkidul)
Total monthly costs per district (operational+capital)		\$519.81	\$384.49	\$544.49
Number health centers per district		18	20	29
Total monthly costs per health center		\$28.88	\$19.22	\$18.78
Approximate total waste/month (kg)		300	60	60
Cost per kg of waste		\$1.73	\$6.41	\$9.07