SURE Rapid Response

What are the different strategies for managing and disposing of medical waste in low income countries?

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This rapid responsewas prepared by the Uganda country node of the Regional East African Community Health (REACH) Policy Initiative.

Key Messages

- Medical waste poses a threat to humans and to the environment; this threat is greater in developing countries due to the use of inappropriate methods of managing the waste, including the use of untrained personnel working with insufficient protection and with poor or no guidance.
- **Children are particularly vulnerable to medical waste that ends up in the open environment.**
- Common forms of clinical waste disposal methods in developing countries found in the literature include **open dumping, land fill and incineration**. Others include **steam sterilization or autoclaving, chemical sterilization, and microwaving** among others.
- None of the available methods are able to get rid of micro-organisms completely and therefore there is an urgency to find an efficient method for the protection of both humans and the environment.
- All medical organisations should develop policies for medical waste management, even those with limited budgets.

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SURE Supporting the Use of Research Evidence

REACH
Regional East African Community Health Policy Initiative

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Who requested this rapid response?

This document was prepared in response to a specific question from a Senior Health policymaker in Uganda.

! This rapid response includes:

- **Summary of research findings,** based on one or more documents on this topic
- **Relevance** for low and middle income countries

X Not included:

- Recommendations
- Cost assessments
- Results from qualitative studies
- Examples or detailed descriptions of implementation

What is the SURE Rapid Response Service?

SURE Rapid Responses address the needs of policymakers and managers for research evidence that has been appraised and contextualised in a matter of hours or days, if it is going to be of value to them. The Responses address questions about arrangements for organising, financing and governing health systems, and strategies for implementing changes.

What is SURE?

SURE – Supporting the Use of Research Evidence (SURE) for policy in African health systems - is a collaborative project that builds on and supports the Evidence-Informed Policy Network **(EVIPNet) in** Africa and the Regional East African Community Health **(REACH)** Policy Initiative (see back page). SURE is funded by the European Commission's 7th Framework Programme.
www.evipnet.org/sure

Glossary

of terms used in this report:
www.evipnet.org/sure/rr/glossary

Background

Concern about the management of medical waste has been growing over the last several decades. This is because of the increasing potential threat it poses to humans and to the environment, as it increases in amounts with advancing technology and sophisticated procedures. There is further concern in developing countries because of the use of inappropriate methods of managing waste, including the use of un-trained personnel working with insufficient protection and without clear policies and guidance(1).

How this Response was prepared

After clarifying the question being asked, we searched for systematic reviews, local or national evidence from Uganda, and other relevant research on the topic. The methods used by the SURE Rapid Response Service to find, select and assess research evidence are described here:

www.evipnet.org/sure/rr/methods

Medical waste contains an assortment of materials, including used sharp objects, blood and other body fluids, body parts, diagnostic samples, soiled dressings, chemicals, pharmaceuticals, medical devices and radioactive materials. Managers need to note that management of medical waste does not only include the handling, storage, treatment, and disposal of medical waste but also the regulation of its generation(2). If not handled appropriately, health care waste potentially exposes health care workers, waste handlers, patients and the communities to infection, toxic effects and injuries, and it risks polluting the environment. Children are particularly vulnerable to medical waste that ends up in the open environment; de Waal and colleagues have shown how illegal dumping of contaminated waste that occurs commonly in South Africa is a serious threat to children yet there is very little information on the management and outcome of these children when exposed to and injured by this medical waste (3).

Furthermore the connection of health care waste with municipal sewage networks in many countries is a public health risk and may create an imbalance in the microbial communities in the sewage system affecting the biological treatment process (4, 5). An additional issue is that of medical waste generated domestically as patients are increasingly taken care of at home and the waste is disposed of with domestic household waste. Most developing countries have capacity constraints with just a few individuals and administrators familiar with the procedures needed for a proper waste management program. Finally, there is no single available method that completely eliminates all risks to the human, public and environment.

The findings in this brief are based on two literature reviews that look at the alternatives for the treatment and disposal of health care wastes (1, 6). In the absence of any systematic reviews[1], these have been based on to summarize the evidence. Guidelines provided by the Centres for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have also been used to inform this paper(2, 8).

Summary of findings

The World Health Organization states that the selection of clinical waste disposal methods be cost effective, easy to implement and environmentally friendly (2). Pruss and colleagues agree with this direction and point out that in addition to cost-effectiveness and being environmentally friendly, waste disposal methods must have assessments to ensure they have minimal risk and minimal impact on human health (9). Others have recently suggested that the methods should also inactivate infectious micro-organisms so as to limit the potential hazard of infectious disease for anyone exposed to the material (6). However, the available methods are far from perfect and do not remove micro-organisms completely and there is an urgent need to find an efficient method for the protection of both humans and the environment.

The most common forms of clinical waste disposal methods in developing countries found in the literature include open dumping, land fill and incineration. Others include steam sterilization or autoclaving, chemical sterilization, and microwaving among others. The table below summarizes the issues around each including their advantages and disadvantages.

[1] A systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question, using rigorous, systematic and explicit methods. Traditional literature reviews differ from systematic reviews because they are prone to bias in a number of ways, brought about by the absence of these systematic methods (7).

Common methods of medical waste disposal in a health care setting

Method	Example of countries using method	Comments Advantages	 Disadvantages
Open dumping and open burning	Algeria, South Africa, Bangladesh, Nigeria, Mongolia	• Most commonly used method in developing countries • Least expensive, no alternative method at this cost • Burning aims to reduce the volume of waste and stop the spreading of light waste e.g. paper	• Potential source for public health infection and environmental pollution • Uncontrolled and inadequate disposal option since waste is accessible to scavengers and animals (infection transmission may therefore be through indirect contact through the food chain or a pathogenic host species). Also wind blowing over the dump site disperses air pollutants to nearby communities • Burning itself is a potential source of toxic emissions especially because waste such as plastics and syringes are burned together with the paper. Toxins like dioxins and furans are generated and other separating air pollutants
Landfill	South Africa, Brazil, Bahrain, Korea, Malaysia	• Easy to imlement • Low cost • Unsophisticated • Secondary option for other waste disposal methods • Sanitary landfills are an option that reduces on the threat to the environment: (Sanitary landfill is a modern engineering landfill where waste is allowed to decompose into biologically and chemically inert materials in a setting isolated from the environment)	• If not properly managed, it raises human health risk and environmental pollution concern although the full extent of this threat has not been scientifically evaluated • Not safe because landfills can produce ○ gas: Although landfill gas consists mainly of methane and carbon dioxide, it can contain a large number of other gases at low concentrations, some of which are toxic. Methane and carbon dioxide, are 'greenhouse gases (GHGs); however while carbon dioxide is readily absorbed for use in photosynthesis, methane is less easily broken down, and it is considered 20 times more potent as a GHG ○ contaminated water: Land disposal of clinical solid waste is often done in low lying areas of an open land, which may be prone to flooding, increasing the possibility of surface water contamination during the rainy season ○ wind-blown litter and dust

			○ landfills also attract vermin • Leachate: this from landfill sites is a threat to surface and ground water systems; it tends to have highly variable concentrations of wide range of salts, halogenated organic compounds, trace metals and organic acids, which may contaminate with surrounding soil and water. It has also been reported that leachate from solid waste landfill site may be mutagenic and carcinogenic • Landfill can be considered as a prolonged survival and dispersal of pathogen micro-organisms from clinical waste; 43 species incl. staphylococcus aureus, Enterococcus spp., Salmonella spp. and other enterobacteriaceae are found in landfill leachate many weeks after clinical waste deposit in landfill
Incineration a high-temperature dry oxidation process that converts the waste into residual ash and gases.	Algeria, South Africa, Palestine, Nigeria, Mongolia South Africa, Brazil, Bahrain, Korea, Malaysia, Mauritius, Libya	• preferred means of treating and disposing clinical solid waste worldwide • It is particularly useful in the treatment of pathological waste and sharps, as these components of the waste stream are rendered unrecognizable. • selected to treat wastes that cannot be recycled, reused, or disposed of in a landfill site. The successful incineration of clinical solid waste within a safe waste management program depends on the form of collection containers, maintenance support, acceptable energy sources, and understandable opera-	• Incineration emits lots of harmful pollutants including carbon monoxide (as a result incomplete combustion), hydrogen chloride, metals (e.g. mercury lead, arsenic, cadmium) dioxin and furan Many of these pollutants, dioxins in particular, can be carried long distances from their emissions source and accumulate in soil, water, and food sources, and pollute them • Incineration is an inappropriate technology for most developing countries due to high financial start-up cost and occupational capital required to implement incineration facilities • There is still some quantity of ash and unburned waste to be disposed of especially at the landfill, which poses significant hazard for the human being and for the environment • Another concern on the risk of infectious micro-organisms is that if infectious clinical waste is incinerated, the emission from stack gas and the ash may have infectious micro-organisms even if the most modern incineration plant is used. Studies have reported bacteria recovered from the base of the exhaust stack of incinerators. The recovered

		tional instructions • a properly designed incinerator can completely burn waste and leave minimum residual in the form of ashes, whilst minimizing the exposure risks to emissions through the correct placement of the units in relation to the clinic and the surrounding communities	bacteria which were isolated were gram positive (Bacillus spp., Staphylococcus aureus and coagulase negative staphylococci) and low number gram negative species (i.e. Pseudomonas fluorescens). The greatest number of micro-organisms was found during the first month, and the number of micro-organisms increased until about 5 months. • Unfortunately, especially in developing countries' hospitals, most of the incinerators are of poor design and have operational problems meaning that the advantages noted above may be lost. The incinerators are locally made and they are constructed from burned bricks and cement .Waste is burned using coal as fuel, which cannot produce required temperature to properly burn the waste. Therefore, high amount of ash is generated because of incomplete burning of waste
Autoclaving and retorts (Retorts are similar in design to autoclaves but do not incorporate a steam jacket)	Mongolia, South Africa, Brazil, Bahrain, Korea	• This is considered as an alternative technology of the incinerator. Autoclaves are generally used to treat sharps, items contaminated with blood, residues from surgery and from isolation wards, bandages, gauze, linen, gowns, and other similar materials and non-chemical laboratory wastes. • Retorts are usually utilized in large scale operations involving more than 1000kg of waste a day.	• More costly method than incineration because, autoclaving is a double treatment option for clinical solid waste, since autoclaving requires another treatment method for final disposal • It cannot handle large quantities of hazardous waste. • Autoclaving cannot treat a variety of chemical and hazardous substances such as wastes from chemotherapy treatment, mercury, volatile and semi-volatile organic compounds, radioactive wastes, and other hazardous chemical wastes • It is not suitable to treat large body parts, animal carcasses, or other large items that, because of their mass and other characteristics, which make it difficult or time consuming for the entire material to reach the prescribed temperatures • The design of retorts results in inefficiencies in heat transfer and consequently higher temperatures are needed for a retort compared to an autoclave.

Microwaving		For this option, it is important that the waste is wet, either as a result of naturally occurring moisture or by the addition of steam, in order to create the thermal process. • Some systems apply low frequency radio waves to inactivate microorganisms contained within the waste. • The microwaves heat the clinical waste from the inside of the materials to their external surfaces.	• Microwaving clinical waste might be economically competitive compared to the incinerator • Microwave technology is not suitable for large scale treatment. • The treatment cost is expensive and is not affordable for the developing countries. • Surveys have also reported that microwaving of clinical waste provides inadequate capability for microorganism sterilization
Chemical disinfection (This relies on the particular properties of the chemical agent to inactivate pathological organisms, with effectiveness also depending on temperature, pH, and presence of other compounds. Includes antiseptics and disinfectants)	Widely used	• May be good for organisms like fungi and vegetative bacteria • Calcium oxide (lime) generally is applied to healthcare wastes and other organic residues at disposal sites in developing countries. In sufficient quantities, it raises the pH to 11 or higher. An alkaline) pH creates an environment that inhibits the survival of microorganisms.	• Some organisms are resistant to chemical treatment • Some of the agents have compounds that are extremely toxic e.g. formaldehyde and ethylene • Alcohols are commonly used but are not effective in destroying fungi, spores and most viruses • When lime is added to the waste, adequate personal protection must be given to the workers applying the lime. Also, liquid discharges from the area must be carefully monitored and managed. These may not be in place for the majority of the time in developing countries

Some points to consider when making a choice

Although it is acknowledged that no single existing method to deal with clinical waste management is adequate in preserving human and environmental health from all possible infection, a choice has to be made. Those making this choice in a low-income setting should consider:

Cost: budgets are usually limited and so a cost-effective method is a must. Consideration may be given to sharing facilities between medical centers to share the cost.

Type of waste: Each type of waste requires specific measures and procedures for handling, storage, collection, treatment and final disposal and destruction. One may need a mix of methods to be able to deal with all waste.

Waste segregation: the design of the program needs to ensure that medical waste is separated into infectious medical waste and non-infectious medical waste at its point of origin. Proper segregation significantly reduces the quantity of infectious medical waste that must be processed. Infectious medical waste should then be discarded directly into containers or plastic bags that are clearly identifiable and distinguishable from all other waste.

Waste management during triage and classification of victims: Since it is generated in an urgent and rapid response activity, it is highly recommended that all wastes generated during this stage, without exception, are stored in containers, preferably in red bags, that are properly labeled as "bio-contaminated waste" and direct contact with such wastes must be avoided. This is because in such situations, the full extent of the kinds of potential infection and possible exposure might not be obvious and in addition the time to assess for it might be limited.

Waste minimization: Significant reduction of the waste generated in health-care establishments and research facilities may be encouraged by the implementation of certain policies and practices, including the following: source reduction measures such as purchasing restrictions to ensure the selection of methods or supplies that are less wasteful or generate less hazardous waste; use of materials that may be recycled, either on-site or off-site; waste segregation: carefully separating waste matter into different categories helping to minimize the quantities of hazardous waste.

Emergency vs long term: In the acute emergency phase, if no better options exist to treat infectious waste, a basic temporary incinerator for medical waste can be used. However, one should be aware of the fact that though it may help reduce the volume of waste to be buried, it will produce toxic smoke, only partially reducing the health risks posed by the waste. The use of incinerators, as opposed to direct

burial, besides exposing the operators to highly hazardous fumes, also creates an additional step in the disposal process, increasing the chances of waste escaping into the environment. For the rehabilitation and reconstruction phases or the longer term after the emergency, long term environmentally friendly options should be selected. Non-burn technologies such as autoclaving should be preferred to incineration techniques, where the option is available.

Proximity and exposure to public: Burial areas should be isolated and protected to avoid illegal recycling. If this is not possible for example, in permanent health facilities, due to lack of space, protected areas should be used at landfill sites to receive treated wastes.

Public Health education: Educating the public about the actual issues and risks associated with clinical or medical waste, is an important consideration. It is often assumed that this is obvious and so is not a common part of public discussion

Post exposure procedures: Even with careful planning and execution it is noted that there will be incidents of exposure for waste handlers, the public and the environment. Waste management plans should have procedures on how to handle such situations.

Policy: There should be a policy or guideline for medical waste management giving standardized guidance for health facilities and health workers in general.

Conclusion

This paper has identified the most common methods used in the management of medical waste, and has further shown the pros and cons associated with each. None of the methods is perfect, which calls for careful examination of the context one is working in. Factors to be considered include the available budget, needs for human resource and training of these and guidelines for the management of any exposure to the public or environment, among others. Clear policy and guidelines for medical waste management are desirable in any setting, including low-income settings.

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REACH
Regional East African Community Health Policy Initiative

The **Regional East African Community Health-Policy Initiative (REACH)** links health researchers with policy-makers and other vital research-users. It supports, stimulates and harmonizes evidence-informed policymaking processes in East Africa. There are designated Country Nodes within each of the five EAC Partner States.

www.eac.int/health

EVIPNet
EVIDENCE-INFORMED POLICY NETWORK

The **Evidence-Informed Policy Network (EVIPNet)** promotes the use of health research in policymaking. Focusing on low and middle-income countries, EVIPNet promotes partnerships at the country level between policymakers, researchers and civil society in order to facilitate policy development and implementation through the use of the best scientific evidence available.

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Conflicts of interest

None known.

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