

Ensuring Injection Safety during Measles Immunization Campaigns: More than Auto-Disable Syringes and Safety Boxes

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Measles immunization campaigns are effective elements of a comprehensive strategy for preventing measles cases and deaths. However, if immunizations are not properly administered or if immunization waste products are not safely managed, there is the potential to transmit bloodborne pathogens (e.g., human immunodeficiency virus and hepatitis B and hepatitis C). A safe injection can be defined as one that results in no harm to the recipient, the vaccinator, and the surrounding community. Proper equipment, such as the exclusive use of auto-disable syringes and safety boxes, is necessary, but these alone are not sufficient to ensure injection safety in immunization campaigns. Equally important are careful planning and managerial activities that include policy and strategy development, financing, budgeting, logistics, training, supervision, and monitoring. The key elements that must be in place to ensure injection safety in measles immunization campaigns are outlined.

Measles immunization campaigns are an effective public health strategy for rapidly increasing measles population immunity, reducing measles incidence, and preventing measles-related deaths [1, 2]. If high coverage is achieved among the susceptible population, transmission of measles virus can be substantially reduced or even interrupted. Following the campaign, if routine immunization services can achieve and maintain high population immunity of each new birth cohort and a second opportunity for measles immunization is provided to most children either through routine services or periodic follow-up campaigns, low measles incidence can be maintained over many years [3, 4].

While the primary objective of the vaccination campaign is to prevent illness and deaths, the overriding concern of any public health intervention must be to

“do no harm.” If not properly administered, injections have the potential to transmit bloodborne pathogens such as human immunodeficiency virus and hepatitis B and hepatitis C [5, 6]. Moreover, used needles and syringes can remain infectious for some time after vaccine administration. Therefore, careful precautions must be taken to ensure injection safety in all immunization activities, including the safe collection, storage, and disposal of used injection equipment [7].

A safe injection can be defined as one that results in no harm to the recipient, no harm to the vaccinator or other health personnel, and no harm to the surrounding community [8]. Measles immunization campaigns pose specific injection safety challenges because they aim at immunizing many thousands of children over a very short time. Each vaccinator is responsible for vaccinating many children, at times under suboptimal conditions.

To prevent possible bloodborne infection among the vaccine recipients, each vaccine dose must be administered with aseptic technique with a sterile needle and syringe. To prevent harm to the vaccinators and other health workers, the used needle and syringe must be

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collected immediately and placed in a secure container. To prevent harm to the surrounding community, safety boxes containing used needles and syringes must be securely stored and disposed of safely. The large number of injections administered during campaigns will inevitably result in a large volume of immunization waste, which if not handled correctly may cause severe waste management problems and increase the chances of safety breaches.

A “safe” immunization campaign ensures that vaccines of assured quality and appropriate injection equipment are used, that all injections are administered safely, and that all used injection equipment is safely collected and disposed of. Proper equipment, such as the exclusive use of auto-disable (AD) syringes and safety boxes, is necessary, but these alone are not sufficient to ensure injection safety in measles campaigns [9]. Equally important are critical managerial activities (e.g., planning, costing, budgeting, financing, logistic considerations, training, supervision, and monitoring) to ensure that all vaccines are administered safely with proper equipment and that all used injection equipment is safely collected and disposed of after use. Here we outline the key elements for conducting measles immunization campaigns with the highest standards of injection safety.

EQUIPMENT FOR SAFE INJECTIONS

AD syringes. The AD syringe was developed in response to a 1986 World Health Organization (WHO) solicitation for proposals [10]. To prevent the transmission of bloodborne pathogens among vaccine recipients, the goal was development of a syringe that physically prevents reuse. Currently, six AD syringe designs have been fully tested and their manufacturers have been prequalified by WHO. To be prequalified, a product must meet WHO specifications and the manufacturing procedures must conform to accepted Good Manufacturing Practices codes. UNICEF only purchases prequalified vaccines and injection materials. The AD syringe designs widely used in immunization campaigns prevent reuse by locking, trapping, or otherwise disabling the syringe piston after a single dose of vaccine is administered.

Because AD syringes can only be used once, they prevent the transmission of bloodborne pathogens between vaccine recipients. Their exclusive use in both mass campaigns and routine immunization services virtually eliminates the risk of infection between vaccine recipients. AD syringes alone, however, do not eliminate the risk of needlestick injuries for health care workers nor do they solve the potential infection problem for the community resulting from improper disposal.

AD syringes available for use in immunization programs are available in two sizes: 0.5 mL capacity for administering vaccines such as measles and diphtheria-tetanus toxoids–pertussis

and 0.05 mL for bacille Calmette-Guérin vaccination. Some syringes have fixed needles with the syringe and needle combined in one unit; others have removable needles. Until now, there has been no comparative study of the various types of AD syringes, and reports from the field on the use of AD syringes have been limited, but positive overall [11].

In 2002, the average UNICEF contract price for 0.5-mL AD syringes was about \$0.06 per syringe. Although AD syringes cost about 20% more than standard disposable syringes, their price has decreased by more than half since 1994. Moreover, the price is expected to decrease even further as production volume increases and additional manufacturers enter the market. In recent years there has been a rapid increase in the demand for AD syringes by national immunization programs. UNICEF estimates it will purchase 550–600 million 0.5-mL AD syringes in 2006 compared with 7.6 million in 1994 (figure 1).

Safety boxes. A safety box is a puncture-resistant, impermeable, and closed container that is used to safely collect and store used injection equipment. To avoid needlestick injuries to themselves and others, health care workers should avoid recapping and deposit needles and syringes into a safety box immediately after each vaccine dose is administered.

For immunization programs in developing countries, safety boxes are typically made of dense cardboard. This material satisfies the characteristics outlined above and provides a relatively inexpensive solution for the safe collection, storage, transport, and final disposal of used injection equipment. The most commonly used safety box has a 5-L volume, holds approximately 100 syringes with needles attached, and costs about \$0.70.

POLICIES, STRATEGIES, AND PLANS FOR INJECTION SAFETY

AD syringes and safety boxes alone will not ensure that all vaccine doses are administered in a safe manner. To ensure that

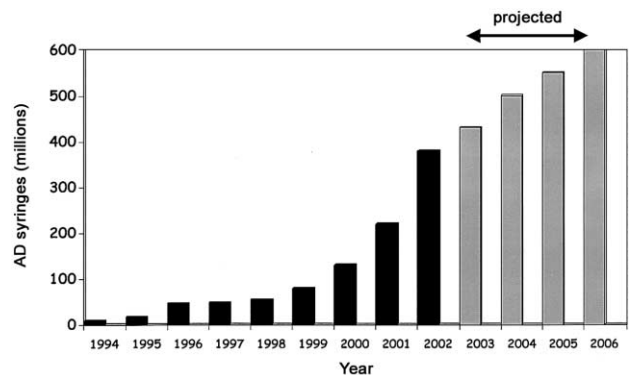


Figure 1. Actual and projected number of auto-disable (AD) syringes purchased annually through UNICEF. Data are from the UNICEF Supply Division.

injection equipment is used safely, complementary injection safety managerial activities must also be in place. To guarantee injection safety, all immunization programs must have appropriate injection safety policies, strategies, and plans.

It is important to endorse the goal of injection safety through a national policy statement. A safe injection policy statement helps inform everyone that injection safety is an important issue for the country and should include the overall goal of ensuring safety for vaccine recipients, health care workers, and the entire community. Once the injection safety policy has been established, an injection safety strategy must be developed to implement the policy.

An injection safety strategy is a general framework that provides guidance for specific actions to be taken. It can be considered an outline of objectives that must be accomplished in order to achieve the overriding goal described in the policy statement. The injection safety strategy is the bridge between the injection safety policy statement and the activities that must be conducted to achieve the policy goal.

Once the injection safety strategy has been developed, the next step is to develop an injection safety plan to implement the strategy. The injection safety plan must ensure the availability of adequate supplies of injection materials at all levels and provide for training of health care workers and monitoring, supervision, and the appropriate management of immunization waste. The injection safety plan must also include a time line, the assignment of responsibilities, and a budget for each activity.

An important component of the injection safety plan is determining the required amounts of injection equipment for each campaign, when these should be ordered, and how they should be distributed throughout the country. For each dose of vaccine administered, there must be one AD syringe and needle. For each vaccine vial, a 5-mL reconstitution syringe must be ordered, and for every 100 syringes there must be at least one safety box. To avoid shortfalls of vaccines, syringes, needles, and safety boxes, an additional quantity (usually 10%–20%) of contingency materials is usually ordered. The distribution of all materials must be planned according to local requirements to ensure that adequate supplies are available at each immunization site.

To promote injection safety, WHO, UNICEF, the United Nations Population Fund, and the International Federation of the Red Cross and Red Crescent societies have adopted the policy that all supplies for immunization programs will be automatically “bundled” with AD syringes and safety boxes [12]. The term “bundling” was chosen to define the concept of a theoretical “bundle,” which must comprise each of the following three essential items: high-quality vaccines, AD syringes, and safety boxes. The implication is that none of the component items can be considered alone; each component must be considered as part of a bundle that contains the other two, and

all components must be included in the budget. Bundling has no physical connotation and does not necessarily imply that all items must be packaged and shipped together.

Training of health care workers is another key activity of an injection safety plan. Each vaccinator needs to be instructed on how to correctly reconstitute measles vaccine, how to prepare safety boxes, and how to use an AD syringe properly. On completion of the injection, all vaccinators must be instructed to immediately place the used AD syringe in the safety box, without recapping, to use a new safety box when the previous box is about three-fourths full (or up to the fill line), and to properly close the full safety box. Finally, personnel at each vaccination site must be trained in the procedures for the appropriate storage and disposal of full safety boxes.

It is important that specific responsibilities for injection safety are clearly stated in staff job descriptions and included in the supervision and monitoring system for the campaign. Injection safety activities should be monitored at the district, provincial, and national levels by use of standard indicators, including the percentages of immunizations given with AD syringes and the percentages of immunization sites with safety boxes. Another important monitoring activity is the establishment of a surveillance system to detect, investigate, and appropriately respond to the potential adverse events following immunization [13]. At the end of each campaign, the activities undertaken should be evaluated and results of the evaluation should be shared with the implementing partners so that the lessons learned can be used for future campaigns.

SAFE MANAGEMENT OF IMMUNIZATION WASTE

While the use of AD syringes and safety boxes in both routine programs and immunization campaigns greatly reduce the risk of person-to-person transmission of bloodborne pathogens for vaccine recipients and health care workers, these obviously increase the generation of immunization waste. The safe disposal of such waste is now widely recognized as a critical component of any immunization activity, but unfortunately there is no single ideal method for safely disposing of immunization waste that suits every situation. Local regulations and conditions and the availability of incinerators or other treatment options must be carefully considered in developing an immunization waste management plan and any method of waste disposal proposed must comply with national and local environmental regulations. Table 1 provides a matrix indicating the relative environmental friendliness of various immunization waste management options versus cost and complexity.

Three methods commonly used in developing countries for the safe disposal of used injection equipment are burying, burning, and incineration. In some situations, other disposal options

Table 1. Matrix of environmentally desirable and technologic complexity/cost of various immunization waste disposal options.

Option	Technologic complexity/cost	
	Simple, low cost	Complex, higher cost
Burning	Burning (<400°C) in pit or in drum or brick incinerator; medium temperature incineration (800–1000°C)	High-temperature incineration (>1000°C)
Nonburning	Waste burial pit/encapsulation; manually operated needle and syringe cutters ^a	Steam sterilization (autoclave or hydroclave) and microwaving; melting; power-operated needle removers/destroyers

^a May need further processing for safe final disposal.

(e.g., autoclaving, shredding, or melting) may also be available. Table 2 summarizes the strengths and weaknesses of the various methods available for processing and disposing of immunization, which are described in more detail below.

Burying/encapsulation. Full safety boxes can be placed in waste burial pits located near health facilities. Pits should be 3–5 m deep, about 2 m wide, and the pit bottom should be ≥ 1.5 m above the groundwater during the rainy season. All pits should be securely fenced to prevent public access. However, unless such security precautions are maintained over time, full safety boxes or individual syringes could potentially be dug up, resulting in risks of bloodborne infection. Moreover, careful supervision is required and care must be taken not to build pits too near water sources such as wells or springs as seepage and contamination of the water supply may occur. When the pit is full, it must be sealed with soil and concrete [14].

Encapsulation is a similar method for safe disposal of immunization waste. The waste is placed in high-density plastic containers or metal drums. When the containers are three-quarters full, they are filled with a medium such as bituminous sand, cement, or clay and after this has solidified, the containers are either buried or disposed of in landfills.

In general, waste burial pits or encapsulation are suitable disposal methods for small health facilities that do not generate large volumes of used injection equipment. Such systems are simple and inexpensive to build, operate, and maintain. However, they are not suitable for areas prone to flooding or with high water tables. Moreover, burying or encapsulation is probably not the most appropriate solution for mass immunization campaigns that generate large volumes of waste.

Low-temperature burning. Used injection equipment may be readily burned in open pits, in simple brick ovens, or in metal drum burners. Such facilities operate at relatively low temperatures (usually <400°C) and are simple and inexpensive to build and easy to maintain. Metal drum and brick ovens are generally preferred over open pits because of their increased efficiency and the potential to reach somewhat higher burning temperatures. Nevertheless, burning at <400°C does not guarantee the complete combustion and destruction of used needles and syringes. Moreover, combustion in such devices is often incomplete and can generate significant smoke with increased potential for atmospheric pollution. Given these shortcomings,

low-temperature burning is clearly not an ideal long-term solution for safe disposal of waste generated from immunization programs, but it may be practical in the short term for dealing with used injection equipment generated from mass immunization campaigns. It may also offer a simple solution for small health facilities until more satisfactory waste management solutions are found.

For low-temperature burning, full safety boxes should be burned in pits 1–2 m in diameter and about 0.5 m deep that are ≥ 50 m from any public buildings. Paper, dry leaves, and wood can be used to start the fire. After burning is completed, a layer of soil should be placed over the ash and residue and the area securely fenced to prevent access by scavengers, children, or the neighboring community.

Medium- and high-temperature incineration. Incineration is defined as intense burning that reduces combustible waste to incombustible matter and results in a significant reduction of waste volume and weight. Incinerators can be classified by the maximum burning temperature achieved: medium temperature (800–1000°C) and high-temperature (>1000°C). In contrast to low-temperature burning, incineration ensures greater combustion and sterilization of used needles and syringes. However, incineration can still produce toxic pollutants such as heavy metals, dioxins, furan, and fly ash. Expensive pollution control devices to prevent the release of these pollutants are generally only available on high-temperature incinerators. Residual ash and waste material that result from incineration must be safely handled (medium-temperature incineration may not completely destroy needles), properly buried, or (ideally) encapsulated to prevent leaching of toxic substances.

Incinerators will not work efficiently unless they are operated properly and receive regular maintenance. Therefore, a well-trained and highly motivated staff is needed to keep incinerators functioning correctly. When planning annual immunization budgets, funds must be set aside for incinerator operation and maintenance costs, including the purchase of fuel where required.

Many types of incinerators are available, ranging from sophisticated and very expensive (>\$100,000) centralized operating plants to basic, relatively inexpensive, stand-alone units suitable for use at district and peripheral levels. Capital costs

Table 2. Comparison of various methods for processing/disposal of immunization waste.

Method	Strengths	Weaknesses
Waste burial pit/cement encapsulation or other immobilizing agent (sand, plaster)	Simple, inexpensive, low tech; prevents unsafe needle and syringe reuse; prevents sharp-related infections, injuries to waste handlers and scavengers	Potential of being unburied (if pit is only soil covered and waste not encapsulated); no volume reduction; no disinfection; pit will fill quickly during campaigns; not recommended for nonsharp infectious wastes; may pose danger to community if not properly buried; inappropriate in areas of heavy rain or if water table is near surface
Burning (<400°C) in pit or drum/brick incinerator	Relatively inexpensive; reduction in waste volume and in infectious material	Incomplete combustion; may not completely sterilize material; heavy smoke and potential fire hazard; may require fuel, dry waste to start burning; toxic air emissions (i.e., heavy metals, dioxins, furans, fly ash) that may violate environmental or health regulations; production of hazardous ash containing leachable metals, dioxins, furans; potential for needlestick injuries (needles not destroyed)
Medium-temperature incineration (800–1000°C)	Less expensive than high-temperature incinerators; reduction in waste volume and in infectious material	Incomplete combustion; potential for heavy smoke; may require fuel and dry waste for start up and maintenance of high temperatures; trained personnel needed to operate; potential emission of toxic air pollutants (i.e., heavy metals, dioxins, furans, fly ash) that may violate environmental or health regulations; production of hazardous ash containing variable amounts of leachable metals, dioxins, furans; potential for needlestick injuries (some needles may not be destroyed); needs constant attention during operation and regular maintenance throughout year
High-temperature incineration (>1000°C)	Almost complete combustion and sterilization of used injection equipment; reduces toxic emissions if pollution control devices installed; greatly reduces volume of immunization waste	Expensive to build, operate, and maintain; requires electricity, fuel, and trained personnel to operate; toxic air emissions (i.e., metals, dioxins, furans, fly ash) may be released unless pollution control devices are installed; may produce hazardous ash containing variable amounts of leachable metals, dioxins, furans
Needle removal/destruction (models range from simple manual and battery operated to more complex electrical)	Prevents needle reuse; reduces occupational risks for waste handlers and scavengers; sometimes plastic may be recycled for other uses after treatment; manual or battery-operated models available	Potential for needlestick injuries during removal; fluid splashes may contaminate work area and/or operator; fluid splash back and used needle manipulation may result in disease transmission; used needles/syringes sometimes need further treatment for disposal; safety profile not established
Melting syringes	Greatly reduces waste volume; prevents reuse	Emission of potentially toxic gases; electricity required; safety profile not established.
Steam sterilization (autoclaving or hydroclaving), microwaving (with shredding)	Long use to treat sharps and nonimmunization health care wastes (hospital staff may be familiar with autoclave technology); range of models (simple to complex) and capacities; sterilizes used injection equipment; less hazardous air emissions (no dioxins, heavy metals) than burning or incineration; reduced waste volume when used with shredder; plastic may be recycled for other uses after separation	High capital cost (but may be less than high-temperature incinerators with pollution control devices); requires electricity and water; high operational costs; high maintenance; may emit volatile organics in steam during depressurization and opening of chamber; requires further treatment to avoid reuse (e.g., shredding); resulting sterile waste requires disposal

of the latter range from the small, locally built, brick incinerators currently used in many African countries, which cost about \$1000, to imported prefabricated, metal incinerators that can cost >\$5000.

The cost per syringe incinerated varies greatly by amount of waste generated; the more the incinerator is used, the less the unit cost. Country studies indicate that the total cost for disposal by incineration, including all components of waste management, range from \$0.08 per syringe for routine health services alone to \$0.02 per syringe when used for both routine services and immunization campaign waste disposal (WHO unpublished data).

Given the capital cost and burning capacity of currently available incinerators, their use at the peripheral health center level will usually not be feasible. The placement of incinerators needs to be carefully considered, both to assure maximum efficiency (i.e., depending on volume of waste generated, it may be reasonable for several areas or health facilities to share the same incinerator) and to avoid an unnecessary environmental nuisance for the surrounding community.

A waste management solution that has proven to be both practical and effective in many countries for both routine immunization services and mass campaigns is the incineration of used needles and syringes on a district basis. Used injection equipment is collected from health centers and mobile teams within the district and transported to the district health facility where there is a well-functioning incinerator. To ensure efficient collection of immunization waste, an “exchange strategy” has been implemented in several countries (e.g., Laos, Cambodia, and Vietnam), whereby new needles, syringes, and safety boxes are given in exchange for full safety boxes.

ADDITIONAL OPTIONS FOR SAFE MANAGEMENT OF IMMUNIZATION WASTE

Needle removal and destruction. Point-of-use needle removal (also termed “defanging”) followed by secure needle storage provides immediate isolation of the potentially contaminated needles, decreases requirements for safety boxes, and helps prevent reuse. Various types of needle removers or destroyers are available, some manually operated; others require an external source of electrical power. One concern with such devices is the potential risk of infection due to the accumulation of fluids originating from the used syringes in the area where needles are removed. Grinding or cutting of the needles into small pieces renders them unfit for reuse and makes them safer for disposal, although risks associated with any accumulated fluid may still be a concern. Research and field studies are in progress to develop needle removal/destruction technologies

that do not require electricity and do not pose an infection risk.

Melting. Specially designed high-temperature industrial ovens can be used to melt and sterilize used needles and syringes. Although the needles do not usually melt in such ovens, they are disinfected and become incorporated into a solid mass of melted plastic and thus no longer pose an infection risk. After cooling, the resulting block of melted plastic and sterile needles can be buried or discarded as landfill waste. The major challenges in implementing such a disposal system are the relatively high capital and operational costs, the need for an electricity supply to each point where ovens will be used, and the generation of considerable smoke and fumes.

Autoclaving and shredding. Autoclaves are commonly used in large medical facilities to sterilize reusable medical equipment and therefore provide a potentially useful method for the sterilization and processing of used injection equipment. An autoclave uses steam as the medium for sterilization, which is created through the combination of sufficiently high temperature, increased pressure, and time of exposure. At autoclave temperatures $\geq 140^{\circ}\text{C}$, many plastic materials soften and form an amorphous mass. In order to destroy used syringes and needles, the autoclaved waste must be fed into a shredder or grinder, which typically reduces the waste volume by 60%–80%. The sterile waste can safely be recovered and recycled for other uses, buried, or safely placed in municipal landfills. Disposing of immunization waste in this manner does not result in the release of smoke, particles, or toxic emissions and is thus an environmentally friendly option.

An autoclave with a capacity of about 250 L costs about \$25,000, while a large autoclave capable of treating 500 kg of waste per cycle may cost >\$50,000. Advanced autoclaves incorporate continuous feeding, internal shredding, mixing, drying, and/or posttreatment compaction. An advanced autoclave with a capacity of about 40–70 kg per hour costs \$47,000–\$70,000.

The disadvantages of using waste disposal autoclaves in developing countries are the expense, the requirement of regular water and electrical supplies, and the technologic complexity. A trained operator is needed and regular maintenance is required. Thus, due to the limited availability of resources in most developing countries, autoclave/shredder systems will probably not be an immediate realistic option. Given the important advantages outlined above, however, and the fact that these devices may also be used to safely process nonimmunization health care waste, autoclave/shredder systems or similar nonburning disposal methods may be applicable in central or highly urbanized locations and may be of interest to policymakers when developing long-term health care waste management strategies and plans.

DISCUSSION

The exclusive use of AD syringes and safety boxes during measles campaigns, combined with appropriate planning, training, supervision, and monitoring, can virtually eliminate the risk of bloodborne infections for both vaccine recipients and health care workers. While the use of AD syringes and safety boxes has greatly reduced the infection risk within health facilities, their use has created another serious problem: the generation of large volumes of used needles and syringes that must be safely disposed of in order to prevent infection risk to the community [15].

Although waste generated from measles campaigns contributes a small percentage of the total health care waste burden in developing countries, careful consideration must be given to finding appropriate methods for safe disposal [16]. At present, there is no ideal solution for immunization waste. The relative risks of transmitting bloodborne pathogens must be considered alongside the potential environmental risks resulting from the processing and disposal of immunization waste. While solving the entire health care waste problem is beyond the capacity of immunization programs alone, solutions for the management of immunization waste can contribute significantly to identifying sustainable solutions for other parts of the health system.

A major obstacle to finding appropriate immunization waste disposal methods is often the lack of adequate financial resources for waste management in immunization services and other health programs. While every measles campaign plan will necessarily budget for AD syringes, safety boxes, and social mobilization, plans for immunization waste management are often neglected or underfunded.

The widely accepted principle of “the polluter pays” obligates the generator of waste or pollution to assume financial responsibility for the costs of appropriate disposal or clean up, and in the longer term the polluter must bear the cost of reducing or eliminating pollution [17]. In this regard, immunization programs are economically responsible for the safe disposal of the used injection equipment they generate. Therefore, immunization program managers must include waste management in their plans for both routine immunization and mass campaigns. To provide adequate funding, donors might consider bundling the support for immunization waste management together with funds provided for the purchase of vaccines, AD syringes, and safety boxes.

Another challenge for safe immunization waste management is the increasingly stringent international environmental regulations governing burning and incineration. With the goal of reducing carbon dioxide levels in the atmosphere and controlling global warming, in 1992 many governments agreed to the UN Framework Convention on Climate Change; in 1994

they adopted the Kyoto Protocol aimed at reducing greenhouse gas emissions [18]. Several nongovernmental organizations are actively campaigning against incineration of medical waste due to the potential environmental risk, including air pollution and possible generation of toxins such as dioxins and furans [19].

While in the short term, developing countries have few realistic and practical alternatives to burying, burning, or incinerating immunization waste generated from mass campaigns and routine immunization services, the risk of generating environmental toxins (e.g., dioxins and furans) can be reduced by controlling what medical waste is burned or incinerated. Dioxins and furans can be generated when materials containing chlorinated hydrocarbons are burned or incinerated [20]. Therefore, medical waste containing chlorinated hydrocarbons, such as polyvinyl chloride (PVC), should not be burned or incinerated. Since syringes are usually manufactured from polypropylene or polyethylene and do not contain PVC or other chlorine-containing components, the risk of dioxin and furan formation from burning or incinerating safety boxes containing used AD syringes and needles is low. Such scrutiny should also be applied to other medical waste that may be burned or incinerated to avoid generation of environmental toxins.

In the future, additional economical, technologically appropriate, and environmentally friendly waste management methods may become available. For example, the feasibility of eliminating burning and incineration entirely and recycling plastic from used syringes into household products such as buckets and kitchen utensils merits further exploration [21]. The ultimate solution to the immunization waste problem may well be the development of needle- and syringe-free vaccine delivery methods (e.g., jet-injectors, aerosols, powders) [22, 23].

In summary, injection safety during measles campaigns can be assured with careful planning, proper equipment, and appropriate training and motivation of health workers so that campaign-generated waste is safely collected and disposed of [24]. Measles immunization campaigns can serve as a model for promoting injection safety in routine immunization services as well as in curative health services. Immunization managers, in collaboration with partners of the Safe Injection Global Network, have the opportunity and obligation to communicate the potential danger of improperly administered injections and to advocate for injection safety throughout the health care system [13].

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