

Use of SoloShot autodestruct syringes compared with disposable syringes, in a national immunization campaign in Indonesia*

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Autodestruct syringes can reduce the improper reuse of syringes, which present a significant risk in the transmission of bloodborne pathogens in developing countries, especially during immunization campaigns owing to the high number of injections given per session. SoloShot is an autodestruct syringe, distributed by UNICEF, which has been shown to be safer and easier to use than standard syringes. This study analyses the accuracy and dose-efficiency of SoloShot, compared with disposable syringes, during a national tetanus toxoid immunization campaign on the Indonesian island of Lombok. Observation and dose measurements revealed that SoloShot syringes delivered more precise and consistent doses and 15% more doses per vial than disposable syringes. Vaccine savings may partially be offset by the higher price of SoloShot. Vaccinators preferred SoloShot, describing it as easier to use, faster, and more accurate than the disposable syringe. The study indicates that SoloShot is highly appropriate for use in immunization campaigns by reducing vaccine wastage and improving injection safety.

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Introduction

The reuse and improper sterilization of syringes present significant risks in the transmission of bloodborne pathogens (1–4). Surveys in developing countries have shown that up to 30% of injections for immunizations are not sterile (5).

Immunization campaigns present their own risks of unsafe injection practices. The influx of large quantities of disposable syringes, usually purchased or donated for these campaigns, could easily lead to improper syringe reuse once the campaign is over. WHO and UNICEF have therefore called for the use of autodestruct syringes in mass immunization campaigns (6). WHO prefers the autodestruct type of disposable syringe for administering vaccines, especially for conducting mass immunizations (7). Such syringes present the lowest risk of person-to-person transmission of bloodborne pathogens because they cannot be reused.

One type of autodestruct syringe, SoloShot, was developed under the USAID-funded HealthTech project and studied in a trial in Pakistan in 1987 (8). It was determined to be safe and effective in preventing reuse, as well as easier and quicker to use than a conventional disposable syringe. The SoloShot syringe, which is available commercially, is distrib-

uted through UNICEF's Supply Division in Copenhagen and is being increasingly used in immunization programmes in developing countries.

SoloShot syringes were used in Indonesia for a national immunization campaign in 1996 as part of the neonatal tetanus elimination programme; approximately 13 million of these syringes were used in the campaign to deliver two doses of tetanus toxoid to women of childbearing age. This article investigates the appropriateness of SoloShot in the Indonesian campaign, compared to a standard disposable syringe, in terms of vaccine wastage, dose accuracy, and user acceptability.

Materials and methods

Syringes and vaccines

SoloShot (Fig. 1) is a plastic disposable syringe equipped with an internal metal clip. After permitting a single filling and injection, the clip locks the plunger and prevents refilling. The clip is set to engage when a dose of 0.5 ml is withdrawn. A 23-gauge, 25-mm needle, suitable for intramuscular injection, is permanently attached. A conventional 3-ml disposable syringe (Becton Dickinson) fitted with a 23-gauge, 30-mm needle was used for comparison in the trial. Ten-dose vials of tetanus toxoid (Perum Bio Farma, Bandung, Indonesia) were used in the study as well as throughout the Indonesian campaign.

Vaccinators and study sites

Vaccinators were regular Indonesian Ministry of Health service personnel and midwives from sub-district-level health centres. All were experienced

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Fig. 1. The SoloShot plastic disposable syringe. After a single filling and injection the internal clip locks the plunger and prevents refilling.



vaccinators in Indonesia's Expanded Programme on Immunization and had delivered at least 100 injections using SoloShot prior to the data collection period.

Training for the national immunization campaign consisted of a one-day session for all vaccinators and managers, including the proper use and disposal of SoloShot. The present study was not announced prior to training, and the training given was considered representative of that conducted throughout Indonesia. The vaccinators received no explanations about the study prior to or during data collection.

The study was conducted during regular national immunization campaign sessions over a 4-day period in December 1996. Observations were made by two provincial-level Ministry of Health supervisors. Each day, one supervisor observed a vaccinator delivering only SoloShot injections, and the other supervisor observed a vaccinator delivering only disposable-syringe injections. Each observer alternated between observing SoloShot injections and disposable-syringe injections on sequential days. Study observations were made at rural immunization posts set up specifically for the national campaign in two

districts on Lombok Island within the province of Nusa Tenggara Barat (NTB). Sites were randomly assigned to SoloShot or the disposable syringe on the day of data collection.

Data collection

During immunization sessions, observers noted the number of doses taken from each vial. To collect samples for dose accuracy, the observers asked the vaccinator to inject one dose from each vial into a pre-weighed container. To minimize possible full- or empty-vial effects on dose accuracy, the third, fourth or fifth dose from each vial was randomly selected for sampling. The vaccinator was asked to inject a dose into the container only after the dose had been withdrawn for regular injection. Only vaccine doses injected into clients and doses collected in bottles were counted as having been delivered. Any unusual event—such as malfunctioning syringes or syringes discarded without being used—was recorded. After injections were complete, the observer used a questionnaire to ask the vaccinators about the syringe they used that day.

Results

A total of 385 doses of vaccine were delivered with SoloShot, while 433 doses were delivered with the disposable syringe. Eight different vaccinators were observed, four using SoloShot and four using disposable syringes (Table 1). Eleven SoloShot syringes (2.8% of the total used) were rendered unusable when the vaccinator tried to expel air from them before complete filling of the device, thereby activating the non-reuse device and preventing complete filling. No disposable syringes were unnecessarily discarded during the study. Three of the four SoloShot vaccinators delivered more doses per vial than their disposable-syringe counterparts. Less inter-vaccinator variation in the mean-dose delivered was recorded among SoloShot users.

SoloShot delivered an average of 1.02 (15%) more doses per vial than the disposable syringe (Table 2). A total of 46 SoloShot doses and 48 disposable-syringe doses were collected and measured. SoloShot provided a mean dose closer to the desired 0.5-ml dose as well as a smaller dose variation.

The volume of full vials was measured and determined to contain 5.01 ml. To determine the amount of vaccine left in discarded vials, 24 discarded vials from each syringe type were collected and the volume of the contents measured. There were no significant differences between the vial residues for the two syringe types, averaging less than one dose per discarded vial. The dead space of each syringe was 0.005 ml for SoloShot and 0.080 ml for the disposable syringe. As a result, an average of 2.6 doses of vaccine per vial used were wasted by users of the disposable syringe, while users of SoloShot wasted 1.2 doses of vaccine per vial used (Table 3).

Table 1. Injection data using SoloShot and disposable syringes

Syringe type and doses delivered	No. of vials used	Mean doses delivered per vial	No. of syringes discarded	Mean dose delivered per injection (ml)
SoloShot				
98	12	8.17	0	0.52
88	11	8.00	0	0.52
85	12	7.08	8	0.51
114	13	8.77	3	0.52
Disposable				
108	17	6.35	0	0.58
115	16	7.19	0	0.60
132	18	7.33	0	0.55
86	12	7.17	0	0.50

Factors contributing to additional vaccine wastage include the expulsion of vaccine prior to injection to eliminate air (disposable syringe only) and discarding partially filled syringes due to accidental activation of the non-reuse feature (SoloShot only). Users of disposable syringes were observed to routinely overfill their syringes and then expel the excess—either into the air or into the vial—to remove the bubbles. Owing to its reduced dead-space design, SoloShot does not fill with as much air as a disposable syringe, thereby reducing the need to eliminate this air; a few taps on the side of the barrel were usually sufficient to expel the bubbles in a SoloShot syringe.

A verbal questionnaire was used to determine user acceptability in a manner similar to the SoloShot study conducted in Pakistan (8). Users preferred SoloShot in 6 of the 9 indicators, including overall preference (Table 4). Vaccinators using each type of syringe were also asked their impressions about the syringes and to list any problems. The following comments were made by users about SoloShot: it required extra care during filling so that bubbles were not drawn in; it was faster to fill and use since the plunger automatically stopped at 0.5 ml; and it was useful for preventing syringe reuse. For the disposable syringe, users commented that it was slower to use since the dose must be adjusted and air expelled and it was more difficult to get an accurate dose.

Vaccinators were also asked if they routinely aspirated while giving immunizations. Three vaccinators responded “never”, three “occasionally”, and two “often”. None of the vaccinators with either syringe type were observed to attempt aspiration during the study.

Discussion

This study provided an opportunity to view the performance and acceptability of SoloShot under typical field conditions. Training of vaccinators in the use of SoloShot was not modified to accommodate the study, and data were collected without disruption of normal procedures. It is therefore assumed that this study is representative of the performance that could be expected from SoloShot if it were introduced in national immunization campaign activities in other countries.

SoloShot delivered approximately one more dose per vial than the disposable syringe, due primarily to the dose delivery being closer to the target dose of 0.5 ml and reduced dead space within the syringe. Wastage analysis (Table 3) revealed that with 5.01 ml of vaccine per vial, SoloShot could optimally deliver an average of 8.8 x 0.5-ml doses per vial, while the disposable syringe could be expected to provide an average of 7.3 x 0.5-ml doses per vial. This corresponds closely with the best-performing vaccinators from each group in this study. The official figures for the province of Nusa Tenggara Barat for the first round of vaccinations in the tetanus toxoid cam-

paign showed an average of 8.5 doses per vial delivered out of the 113 000 SoloShot injections given. It should be noted that the 10-dose vials of tetanus toxoid used in the Indonesian campaign were filled with only 5.01 ml of vaccine, making it impossible—in practice—to deliver 10 doses per vial.

SoloShot also had significantly greater accuracy than the disposable syringe. This contributed

Table 2. Summary data for doses by SoloShot and disposable syringes

	SoloShot	Disposable	P-value
Mean doses delivered per vial	8.02	7.00	<0.001
Average dose per injection (ml)	0.516	0.556	<0.001
Dose range (ml)	0.46–0.53	0.47–0.66	—
Dose standard deviation (ml)	0.013	0.050	—

Table 3. Wastage analysis (per vial used) with SoloShot and disposable syringes

	SoloShot	Disposable
Dead-space wastage (ml)	0.04 (0.005 x 8 doses per vial)	0.56 (0.080 ml x 7 doses per vial)
Overfill wastage (ml)	0.13 (0.016 ml x 8 doses per vial)	0.37 (0.56 ml x 7 doses per vial)
Vial remnants discarded (ml)	0.44	0.37
Total wastage per vial (ml)	0.61 (1.2 doses)	1.32 (2.6 doses)

Table 4. User acceptability survey (8 respondents)

Question	% of vaccinators who preferred SoloShot
Which syringe allowed you to withdraw vaccine more easily from a full vial?	63
Which syringe allowed you to withdraw vaccine more easily from a vial with few doses remaining?	0
Which syringe allowed you to expel air bubbles more easily?	25
Which syringe allowed you to aspirate for blood more easily?	38
Which syringe allowed you to give the correct dose more easily?	88
Which syringe allowed you to complete the injection more easily?	88
Which syringe was easier to use?	88
Which syringe was faster to use?	88
Which syringe would you prefer to use?	63

to vaccine savings and could play a role in improved vaccine efficacy where dose accuracy is important.

The 15% saving in tetanus toxoid delivered by SoloShot may not represent a significant overall saving—especially in light of the higher syringe wastage that might be expected from the occasionally discarded SoloShot arising from air that could not be expelled. In this study, 11 SoloShot syringes were wasted, while about 40 doses of vaccine were saved by using SoloShot. At a UNICEF price of US\$ 0.10 per SoloShot and a tetanus toxoid cost of US\$ 0.05 per dose, the vaccine cost savings were halved by the syringe wastage. However, the increased efficiency of SoloShot could be a significant economic benefit if it were used with more expensive vaccines such as hepatitis B, *Haemophilus influenzae* type B (Hib), or quadrivalent vaccines.

Vaccinators indicated a strong preference for SoloShot, considering it easier, faster, and more accurate to use. However, one vaccinator experienced significant difficulties with SoloShot, accounting for 8 of the 11 SoloShot discards. This was the oldest and most experienced vaccinator of the group, and he had difficulty modifying his syringe-filling technique so as not to withdraw large amounts of air into the syringe. Given the small sample size of this study, it is difficult to say to what extent this problem may occur with other vaccinators; however, it is an indication that, during training, special attention should be paid to modifying the vaccine withdrawal procedures—especially among experienced vaccinators.

While SoloShot improves injection safety by eliminating reuse of syringes, other safety issues may also be considered. Disposal boxes were supplied by the manufacturer and used in the Indonesian tetanus toxoid campaign; occasionally, however, it was observed that the syringe supply exceeded the dis-

posal-box capacity, resulting in over-filled boxes and protruding syringes. With SoloShot—as with all disposable syringes—care must be taken to ensure compliance with proper disposal techniques.

Recapping of both SoloShot and disposable syringes was frequently observed. While no needlestick injuries were observed for either syringe type, recapping presents a danger to health workers. Training should emphasize immediate insertion of the syringe into the disposal box without recapping.

This study indicated that use of SoloShot is highly appropriate in a national immunization campaign setting. It could reduce vaccine wastage while improving injection safety. The study also confirmed the findings of the SoloShot evaluation conducted in Pakistan—specifically, that it was preferred by vaccinators and can be used properly and safely with a minimal amount of training. ■

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Résumé

Utilisation comparée des seringues autobloquantes SoloShot et des seringues jetables dans le cadre d'une campagne nationale de vaccination en Indonésie

L'utilisation de seringues autobloquantes pourrait faire reculer la réutilisation indue des seringues, un grave problème pour les programmes de vaccination des pays en développement. De par leur nature même, les campagnes de vaccination nécessitent de grandes quantités de seringues jetables, susceptibles d'être facilement réutilisées une fois la campagne achevée. L'UNICEF distribue une seringue autobloquante, la seringue SoloShot, qui s'est révélée plus sûre et d'un usage plus commode que les seringues classiques. La présente étude a consisté en une analyse de la précision et de l'efficacité de dosage de la SoloShot, comparativement à la seringue jetable, lors d'une campagne nationale de vaccination par l'anatoxine tétanique dans l'île indonésienne de Lombok.

On a observé les faits et gestes de quatre vaccinateurs titulaires qui utilisaient des seringues SoloShot et de quatre autres qui utilisaient des seringues jetables classiques. Les vaccinateurs n'avaient pas reçu d'instructions ni de formation particulières autres que

celles habituellement données par le Ministère indonésien de la Santé aux utilisateurs de ces types de seringue. On a noté le nombre de doses délivrées par ampoule ainsi que tous les problèmes qui se posaient. Il avait été en outre demandé aux vaccinateurs d'injecter de temps à autre le contenu d'une seringue dans une ampoule pour mesurer la dose délivrée. Après chaque séance, on demandait aux vaccinateurs quelle seringue avait leur préférence.

Les seringues SoloShot ont délivré 8,02 doses par ampoule, contre 7,00 doses pour les seringues jetables, soit une différence de 15%. Par ailleurs, les SoloShot ont délivré une dose moyenne de 0,516 ml par injection contre 0,556 ml dans le cas des seringues jetables. Il n'y avait pas de différence entre les deux seringues pour ce qui est de la quantité de vaccin restant dans les ampoules après utilisation. Toutefois l'espace mort de la seringue, c'est-à-dire le volume de vaccin qui reste à l'intérieur sans pouvoir être injecté, s'est révélé être

beaucoup plus faible dans le cas de la SoloShot. Il apparaît que la réduction de l'espace mort et la meilleure précision obtenue dans la dose délivrée sont à la base de la plus grande efficacité de la seringue SoloShot. Il est vrai cependant que l'économie de vaccin ainsi réalisée pourrait être contrebalancée par le coût plus élevé de la SoloShot.

Les vaccinateurs ont donné la préférence à la seringue SoloShot pour sa plus grande facilité d'utilisation et sa précision supérieure à celle de la seringue jetable. L'un d'entre eux a cependant eu des difficultés

avec la SoloShot : il aspirait systématiquement de l'air et actionnait prématurément le dispositif de blocage en tentant de l'éliminer. Lors de la formation, il faudra donc attirer l'attention des vaccinateurs – notamment de ceux qui sont expérimentés – sur la modification de la technique d'aspiration qu'impose la nouvelle seringue.

Cette étude montre que la seringue SoloShot convient tout à fait aux campagnes de vaccination car elle réduit les pertes de vaccin et garantit une meilleure sécurité des injections.

Resumen

Comparación del uso de las jeringas autodestructibles SoloShot y de las jeringas desechables en una campaña nacional de inmunización de Indonesia

Las jeringas autodestructibles pueden reducir la reutilización de las jeringas, que es uno de los grandes problemas de los programas de inmunización de los países en desarrollo. Para las campañas de inmunización se dispone habitualmente de grandes cantidades de jeringas desechables, que pueden fácilmente ser reutilizadas una vez finalizada la campaña. El UNICEF distribuye una jeringa autodestructible, conocida como SoloShot, que, según se ha comprobado, es más segura y más fácil de utilizar que las jeringas de uso corriente. En este estudio se analizaron la precisión y la eficiencia de la dosificación de la jeringa SoloShot en relación con las jeringas desechables durante una campaña de inmunización con anatoxina tetánica realizada en la isla indonesia de Lombok.

En esa campaña se procedió a la observación de cuatro vacunadores que utilizaban jeringas SoloShot y cuatro que empleaban jeringas desechables estándares. Los vacunadores no recibieron instrucciones ni adiestramiento especial, salvo el adiestramiento habitual del Ministerio de Salud de Indonesia para el uso de ambos tipos de jeringas. Se hicieron observaciones del número de dosis administradas por vial y de los problemas ocurridos. Se pidió a los vacunadores que ocasionalmente inyectaran el contenido de una jeringa en un vial para medir la dosis. Después de cada sesión, se recabó la opinión de los vacunadores con respecto a las jeringas.

Las jeringas SoloShot permitieron administrar 8,02 dosis por vial, mientras que con las desechables

se pudo administrar 7,00 dosis por vial, lo que representa una diferencia del 15%. Las jeringas SoloShot suministraban una dosis media de 0,516 ml por inyección; para las jeringas desechables, en cambio, esa dosis era de 0,556 ml por inyección. Los restos de vacuna en los viales descartados no revelaron diferencias entre los dos tipos de jeringas; no obstante, se determinó que el espacio muerto de cada jeringa (la vacuna que queda en la jeringa y no puede ser inyectada) era mucho menor en las jeringas SoloShot. La reducción del espacio muerto y la mayor precisión del volumen de la dosis se consideraron los factores principales que permitían hacer un uso más eficaz de la vacuna utilizando las jeringas SoloShot. Sin embargo, el ahorro de vacuna en parte puede quedar contrarrestado por el precio más elevado de este tipo de jeringas.

Los vacunadores prefirieron la SoloShot, a la que describieron como más fácil de utilizar, más rápida y más precisa que la jeringa desechable. Un vacunador tuvo dificultades con la SoloShot: varias veces dejó pasar aire a la jeringa y activó prematuramente el dispositivo de autodestrucción al tratar de expelerlo. Durante el adiestramiento debe prestarse especial atención a la modificación de los procedimientos de aspiración que exige la nueva jeringa, especialmente en el caso de vacunadores experimentados.

En el estudio se indica que la jeringa SoloShot es muy apropiada para su utilización en campañas de inmunización, ya que permite reducir las pérdidas de vacuna y mejorar la seguridad de la inyección.

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