

Evaluation of a Retractable Syringe in South Africa

Acceptability, safety, and cost implications

KwaZulu Natal, South Africa.

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Executive Summary

Each year, more than two million needlestick injuries occur among health care workers worldwide.¹ Needlestick injury carries risk of infection that could be prevented through safe injection practices such as the use of safer medical devices. Injection providers, medical waste handlers, and communities in developing countries are at particular risk due to the prevalence of unsafe injection and sharps disposal practices including syringe reuse, inadequate waste storage facilities, and lack of access to safer medical devices.

In South Africa, research suggests that needlestick injuries are common and underreported.² Retractable syringes—autodisable syringes with the ability to automatically retract the needle immediately after injection—are an effective means for eliminating needlestick injury and preventing reuse. In 2005 and 2006, KwaZulu Natal was the only province in South Africa to have introduced retractable syringes into selected health facilities. To evaluate the effects of using retractable syringes, PATH conducted an operational study in KwaZulu Natal in 2006–2007. The study assessed the acceptability, perception of safety, effect on waste management, and cost implications of using retractable syringes in immunization and curative settings.

The evaluation was conducted at ten health facilities in the Ugu and uThukela districts of KwaZulu Natal province. To ensure representation across a spectrum of health care scenarios, PATH and the KwaZulu Natal Department of Health conducted the evaluation in one regional hospital, one district hospital, seven clinics (three urban and four rural), and one mobile clinic. The research included focus group discussions and individual interviews with over 99 respondents, observations of injection and waste handling practices, and an anonymous questionnaire to gather information from health care workers on needlestick history.

A spreadsheet-based model was developed to estimate costs, benefits, and cost-effectiveness of the impact of retractable syringes on needlestick injuries and unsafe injection for multiple settings. Data on resources and direct costs were collected along side the evaluation of health facilities to obtain estimates of resource use and direct costs for providing injections; managing needlestick injuries; and treating HIV and chronic hepatitis B and hepatitis C infections.

While a detailed description of the study findings is included in this report, the following examples illustrate how the use of retractable syringes can influence injection practices and decision-making in health care settings.

Acceptability

All 56 injection providers reported that the retractable syringe consistently worked well and always retracted. Nurses reported using retractable syringes predominantly for intramuscular injections including immunizations and injectable contraceptives and antibiotics. Reported benefits of retractable syringe use included safety, time savings, and reduced waste volume compared to disposable syringes. A majority of supervisors reported improved health worker job satisfaction with retractable syringe use, while most respondents felt that retractable syringes had little effect on patient satisfaction because few patients realized a safety device was being used.

Safety

Since the introduction of the retractable syringes, a majority of respondents reported a decrease in needlestick injuries and noted feeling safer when using retractable syringes rather than

disposable syringes; this group also noted medical waste practices were safer. Participants found retractable syringes to be less advantageous in hospital settings where disposable syringes and other sharps are used for an array of non-injection procedures (e.g., intravenous and phlebotomy applications).

An anonymous questionnaire to health workers collected information about the number of needlestick injuries received in the past 12 months and the circumstances of their most recent injury. Out of 146 respondents, 15 health workers reported 25 needlestick injuries in the past 12 months. The most common reported reasons for needlestick injury included unexpected patient movement, needle recapping, clean up/waste collection, and collision with co-worker. Four (4) of the twenty-five (25) needlesticks occurred using a retractable syringe. Reasons for needlesticks using a retractable syringe included “cannula insertion” and unexpected patient movement; two respondents offered no explanation. Eight (8) of the fifteen (15) respondents who experienced a needlestick in the past year reported the injury to the supervisor; six (6) of those also received post-exposure prophylaxis (PEP).

Willingness to treat HIV-positive patients

Nearly all supervisors reported that the retractable syringes increased nurses’ willingness to treat HIV-positive patients.

Waste management

Respondents reported that retractable syringes were disposed of into sharps containers, similar to disposable syringes. The majority of injection providers and supervisors believed retractable syringes resulted in less waste volume in comparison to disposable syringes because the retracted needle did not take up space within the sharps container. A volume comparison found a five-liter sharps container held 50% more retractable syringes than standard disposable syringes.

Training

All nurses reported ease in learning to use the retractable syringe; however, many did not receive sufficient training prior to use. All supervisors noted the importance of formal training to ensure that nurses were not caught unaware following needle retraction. Several nurses and supervisors reported insufficient or lack of training as a barrier to retractable syringe use in clinic settings and certain hospital wards.

Cost

A cost analysis evaluated costs associated with use of the retractable syringe and cost savings gained from reduced rates of needlestick injury and syringe reuse. Compared to a disposable syringe, the purchase price of the retractable syringe was the only cost increase. Cost reductions were found in PEP, HIV treatment, and medical waste disposal.

Since rates of needlestick and syringe reuse are not well documented, a sensitivity analysis compared costs at different rates of these variables. It should be noted that no syringe reuse was observed or reported in KZN during the evaluation. The sensitivity analysis was conducted for the benefit of other provinces in South Africa, and other countries in the region, which have varying rates of syringe reuse. Even at conservative rates of unsafe injection (2% syringe reuseⁱ

ⁱ Expert opinion from Robin Biellik, PATH. Former WHO advisor for immunization, southern Africa region.

and 2.2 needlesticks per nurse per year) the retractable syringe was found to be cost saving. Syringe reuse would have a much larger cost impact than needlestick injury.

Although already a cost-saving intervention at current prices, the South African purchase price of the retractable syringe is much higher than in other public health programs. This price can be expected to decrease as demand and sales volumes in South Africa increase. This will further increase the cost-effectiveness of the retractable syringe.

Conclusions and recommendations

Medical transmission of HIV and other bloodborne diseases affects the lives of health workers and patients. Injection safety is one aspect of the problem that can be improved through simple interventions such as use of retractable syringes. The use of retractable syringes in Kwa Zulu Natal province has shown them to be preferred by South African health workers due to the needlestick protection they provide. By allowing health workers to feel safer in their jobs, retractable syringes have the potential to improve quality of care while reducing HIV infection rates and reducing health care costs. The study team recommends expanding the use of retractable syringes in South Africa and considering other “safe sharps” technologies such as improved blood drawing equipment and safer IV devices. Along with continued prioritization of occupational safety and infection control training, these interventions could minimize HIV due to medical transmission.

Introduction

Background

Each year, more than 16 billion injections are administered worldwide.³ Of these, 95% are curative in nature and 5% are administered in immunization settings. The World Health Organization (WHO) estimates that more than 50% of injections given in developing countries are unsafe.⁴ In general, a safe injection is administered using appropriate equipment without harming the recipient and does not expose the provider to any avoidable risks, or result in waste that poses a hazard to the community.

Globally, unsafe injections account for 33% of new hepatitis B infections, 42% of new hepatitis C infections, and 2.5% of new HIV infections.⁵ In the southern Africa region, these proportions rise to 47%, 45%, and 5% respectively. Studies of unsafe injection practices consistently demonstrate that overall 20% of injections in Africa are unsafe.⁶

WHO estimates that two million needlestick injuries occur each year among health care workers worldwide. Health care workers may experience needlestick injury while administering a vaccine or a curative injection, recapping a needle, disassembling a syringe, or disposing of medical waste. The US Centers for Disease Control and Prevention estimates that in the United States—depending on the type of device used and the procedure involved—62% to 88% of sharps injuries could potentially be prevented by using safer medical devices.⁷

National context

Curative injections in South Africa are given using primarily plastic disposable syringes which have been linked to transmission of bloodborne pathogens through accidental needlesticks. Injuries from needlesticks and other medical sharps are one of the greatest occupational risks faced by health care providers in South Africa. While South Africa has high injection standards, past research on injection safety highlighted gaps in injection safety practices in the public health sector, suggesting that unsafe medical injections contribute to the transmission of hepatitis B and C and HIV in health care settings.²

South Africa's rates of HIV are some of the highest in the world, with an estimated 6.3 million people or 18.8% of the adult population infected with HIV and AIDS.⁸ The prevalence of HIV among the hospitalized population is estimated at 54%.⁹

Although sexual transmission represents the primary manner in which HIV is spread, unsafe injection practices remain common in South Africa. A 1998, WHO survey of multiple health centers in sub-Saharan Africa showed that 15% of facilities reused syringes and needles.¹⁰ A study in Gauteng province, South Africa, observed a small number of injection providers in a large hospital. In 62% of the injections observed, the injection equipment was not discarded immediately after the injection, and 67% of the sharps containers observed were overfilled with needles and syringes.²



WHO data suggest that African health care workers experience an average of two to four sharps injuries per year.¹¹ In South Africa, several studies suggest that needlestick injuries are common and underreported.² Results from a recent anonymous needlestick survey at two facilities in Gauteng province found between 17% and 22% of health care workers experienced needlesticks in the past year, and more than half did not report the injury.² Furthermore, a 1998 study in Johannesburg and Soweto showed that 83% of hospital interns experienced at least one percutaneous injury, and 43% of these were from an HIV-positive source patient.¹² That same study found that only 64% of needlestick injuries were reported.

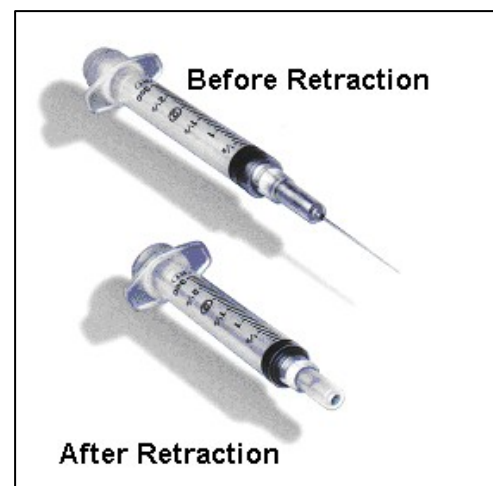
In addition, health care workers who experience needlestick injury are also at risk of contracting hepatitis B, which is widespread in South Africa. Between 10% and 18% of South African adults are hepatitis B virus carriers. Infection is more common in certain areas of the country—for example, Eastern Cape and KwaZulu Natal provinces.^{13,14}

Improving the safety of medical injections

To decrease the risk of disease transmission from unsafe injections, WHO guidelines recommend using autodisable (AD) syringes for immunizations and disposing of used syringes and needles in puncture-resistant sharps containers that are then burned or incinerated. In developing countries where reuse is most common, safe sharps disposal policies and practices are often inadequate. Assessments in China, India, and six African countries showed that health workers often mix sharps waste into other waste streams, dispose of waste haphazardly in and around their clinics, and do not maintain regulated systems for safe disposal of sharps waste for all injections.^{15,16,17}

AD syringes are used for more than 50% of immunization injections globally. They are promoted by the GAVI Alliance partners as the most effective way to reduce the reuse of syringes and, therefore, transmission of bloodborne infections such as hepatitis B, hepatitis C, and HIV. However, an important limitation of AD syringes is that they do not protect against needle sticks.

In several recent field evaluations, health workers found retractable syringes to be a durable and well-accepted alternative means of providing injections and managing sharps waste.^{18,19} The needle automatically retracts immediately after the injection is given. The retractable syringe provides immediate isolation of the needle preventing syringe reuse, the primary transmission risk of bloodborne infection. In addition, because the needle is encased in the syringe after use, the risk of needlestick injury is significantly reduced and medical waste handling is simplified. Once retracted, the syringes are no longer considered sharps waste and can be collected either in a sharps container or with other infectious waste in plastic bags, and then disposed of by autoclaving and shredding, incineration, or through plastics reprocessing.



Currently, retractable syringes are more expensive than disposable syringes, but the cost-effectiveness compared to current practice is unknown. Because the product is new to the market, cost will be reduced when the purchase volume increases.

PATH chose KwaZulu Natal (KZN) province, South Africa, as the evaluation site due to the country's high rates of hepatitis B and Cⁱⁱ and HIV, commitment to waste management as evidenced by the National Waste Management Strategy, strong capacity for conducting research, and potential to sustain retractable syringe procurement. In addition, KZN was the first province to introduce the retractable syringe into selected health facilities.

Evaluation Objectives

The aim of this operational study was to assess the acceptability, perception of safety, effect on waste management, and cost implications of using retractable syringes instead of disposable syringes in selected facilities in KZN, South Africa.

The objectives of this evaluation were to:

1. Assess the acceptability of retractable syringes among health workers and waste handlers in KZN.
2. Observe the effect retractable syringes have on health workers' and waste handlers' perceptions of health and safety, including needlestick injuries.
3. Describe the effect of retractable syringes on waste management practices in KZN.
4. Conduct an economic evaluation outlining the costs and benefits of using retractable syringes—instead of disposable syringes—in curative and immunization settings.

This report summarizes the findings of the evaluation and outlines recommendations regarding the use of retractable syringes in South Africa.

Evaluation Design

Study sites

The evaluation was conducted at ten health facilities in the Ugu and uThukela districts of KZN. The KZN Department of Health (DOH) suggested facilities already using retractable syringes for at least one year to ensure that health workers studied had sufficient experience in retractable syringe use and disposal. PATH and the KZN DOH conducted the evaluation in one regional hospital, one district hospital, seven clinics (three urban and four rural), and one mobile clinic (Ugu District: one hospital, two clinics, one mobile clinic; uThukela District: one hospital, five clinics). In both districts, clinics receive logistical support from the central hospital to order supplies via the hospital stores department which manages the clinics' budgets and handles procurement on their behalf. The evaluation team selected hospitals and clinics that are representative of typical facilities in South Africa in regard to size, accessibility, and types of services offered.

ⁱⁱ Source of KZN hepatitis B and C rates: head virologist at UKZN

Retractable device

This evaluation used the VanishPoint® Syringe, manufactured by Retractable Technologies, Inc., based in the United States. The local supplier in South Africa is Lechoba Medical. Syringe and needle come as a single unit. The syringes are manufactured in 1-cc, 3-cc, 5-cc, and 10-cc sizes, with needle diameter ranging from 20 G to 25 G; needle lengths range from 5/8 to 1½ inch. The smallest needle sizes are intended for intradermal and subcutaneous injections, and larger sizes are intended for intramuscular (IM) injections. The retractable syringe is not indicated for blood collection. Not all retractable syringe sizes were in KZN facilities during the pilot introduction phase.



Methods

The research team consisted of a PATH project researcher and two Zulu-speaking research assistants. The following data collection methods were used in the evaluation. All data collection tools are attached in Appendix A.

1. *Focus group discussions with injection providers and waste handlers* gathered qualitative information about the attitudes, beliefs, and practices of health workers regarding injection safety, retractable syringes, and waste management. In smaller facilities such as clinics, waste handlers participated in in-depth interviews rather than focus group discussions.
2. *In-depth interviews with supervisors* collected information on issues related to supervisor's perceptions of injection safety, use and acceptability of retractable syringes, and waste management practices.
3. *In-depth interviews with decision-makers* determined the criteria employed at the provincial level in the decision to order retractable syringes.
4. *Anonymous questionnaires* collected confidential information on needlestick injuries from injection providers, waste handlers, and supervisors. Completed questionnaires were returned anonymously to a locked box at each facility.
5. *Observation of injections* documented the use of retractable and disposable syringes at each facility.

| Needle Gauge | Attached Needle Lengths | Syringe Sizes | Uses |
|--------------|-------------------------|--------------------|--|
| 20G | 1"-1 1/2" | 3ml 5ml 10ml | IM and deep IM injections Thick medications Example: Insulin |
| 21G | 1"-1 1/2" | 3ml 5ml 10ml | IM and deep IM injections Slightly thick medications |
| 22G | 1"-1 1/2" | 3ml 5ml 10ml | IM and deep IM injections |
| 23G | 1"-1 1/2" | 3ml | SC or IM |
| 25G | 5/8"-1" | 1ml 3ml | SC or IM (for thin patients) Example: Immunization |
| 27G | 1/2" | 1ml | SC or ID Example: TB Skin Testing |
| 29G | 1/2" | 1ml | SC Insulin Administration Orange packaging and needle cap |

► Reduces the risk of needlestick injuries
 ► No needle changing
 ► Non-reusable

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6. *Cost data collection forms* captured facility-level cost data to estimate the direct costs for supplies and labor associated with the use and disposal of retractable syringes. Secondary data from the KZN DOH were used to estimate the costs associated with the treatment of HIV and hepatitis B and C infections.

Researchers conducted the discussions and interviews with injection providers, supervisors, and decision-makers in English and with waste handlers in Zulu. The interviews and discussions were audiotaped and transcribed within one week of the site visits. Discussions conducted in Zulu were translated to English during the transcription process. Data were analyzed manually based on the key themes of the research. See Appendix A for focus group discussion and interview guides.

Respondents and sample size

Table 1 shows the respondent details for this evaluation study. The study team conducted 14 focus group discussions with injection providers, 3 focus group discussions with hospital-based waste handlers, 11 in-depth interviews with waste handlers, 16 in-depth interviews with supervisors, and 2 in-depth interviews with provincial-level decision-makers.

Table 1: Evaluation project respondents

| Respondent category | Number of focus groups | Number of individual interviews | Total number of respondents | Number of observations | Total number of anonymous questionnaires |
|----------------------------|------------------------|---------------------------------|-----------------------------|------------------------|--|
| Injection providers | 14 | 0 | 56 | 52 | -- |
| Waste handlers | 3 | 11 | 25 | -- | -- |
| Supervisors | 0 | 16 | 16 | -- | -- |
| Provincial decision-makers | 0 | 2 | 2 | -- | -- |
| TOTAL | 17 | 29 | 99 | 52 | 146 |

Survey respondents included:

Injection providers: enrolled and professional nurses.

Waste handlers: general assistants who clean and manage waste and groundskeepers who oversee the storage and collection of medical waste.

Supervisors: sisters in charge (head nurses) in the clinic setting; and ward supervisors, infection control nurses, occupational health nurses, and nursing managers in the hospital setting.

The study used purposive sampling, selecting participants of each respondent category available at the time of field work. Participation was voluntary; all participants in group discussions, individual interviews, and observations signed an informed consent form prior to participating. Informed consent was not obtained from health workers who completed the anonymous questionnaire; the instrument did not record participant or health facility details.

Economic evaluation

A spreadsheet modelⁱⁱⁱ was used to evaluate the costs and benefits of replacing disposable syringes with retractable syringes for 80% of injections in hospital and clinic settings in KZN. The model used data from a representative regional hospital and a typical clinic from the study facilities in Ugu and uThukela districts to estimate:

- Costs of providing injections in both immunization and curative settings.
- Number of needlestick injuries per health care worker.
- Costs associated with needlestick management and treatment associated with HIV, hepatitis B, and hepatitis C.

Cost of introducing the retractable syringe

The research team obtained financial records and budget estimates from KZN DOH for the two participating districts. The team interviewed KZN health service staff from the study facilities in Ugu and uThukela districts as well as provincial level managers to supplement financial data and to obtain specific information on resources used and costs incurred for introducing retractable syringes at the district level.

The data were compiled into an Excel spreadsheet model to estimate the incremental cost and total net costs associated with using the retractable syringe. The **incremental cost** of introducing retractable syringes is equal to the cost difference between the retractable syringe and the disposable syringe and needle, plus any changes in personnel and waste disposal costs associated with the use of retractable syringes. The **total net costs** are equal to the total incremental costs of introducing retractable syringes minus the medical costs saved by reducing needlestick management and treatment costs.

For the **incremental cost analysis**, data represent direct costs involved in using retractable syringes for injections in the representative facilities. The **direct costs** include the financial costs associated with labor and supplies for providing injections, as well as the required preparatory and planning activities at the provincial and district levels, prior to introduction of retractable syringes. The **cost data** represent the direct costs that changed as a result of introducing retractable syringes. Costs that did not change as a result of using retractable syringes are not included in the analysis. The cost data also represent the cost to the government for these programs. Appendix C and Appendix D Table D1 provide detailed information on how costs were estimated, including unit costs for injection supplies.

Cost analysis of needlestick injuries

This analysis used an estimate of needlestick injuries among enrolled nurses providing injections; the estimate did not include others who might receive needlestick injuries, such as waste handlers, housekeeping staff, lab technicians, and doctors. Researchers used the number of health workers from a representative regional hospital and a clinic setting in the study districts. Approximately 200 enrolled nurses provided injections in the hospital setting; in the clinic setting, the average number of enrolled nurses was 2—ranging from 1 to 5 enrolled nurses.

ⁱⁱⁱ Details of the cost models, including the excel spreadsheets, are available from PATH upon request.

When examining needlesticks, the model assumed:

- Health workers receive an average of 2.1 needlestick injuries per person per year—32% of these injuries are attributable to disposable syringes used for injections, and therefore, can be prevented by switching to retractable syringes.
- Only 60% of all health workers report their needlestick injuries.^{20,21}

Cost analysis of needlestick management and treatment

The team used a decision tree to estimate the number of health workers who receive post-exposure prophylaxis (PEP) for HIV exposure as well as the number of health care workers who receive treatment for HIV infections and chronic cases of hepatitis B and hepatitis C. The decision tree for estimating these treatment costs was based on:

- Health workers' hepatitis B, hepatitis C, or HIV status.
- HIV status of the source patient of the needlestick.
- Effectiveness of PEP for HIV.
- Risk of infection resulting from a needlestick injury.

We assumed 18.8% of health care workers and patients in South Africa are already infected with HIV.⁸ It was also assumed that all injured workers who reported needlestick injuries were offered and completed PEP and that the efficacy for this preventative treatment for HIV is 81%.²²

To model the number of health care workers likely to be infected with hepatitis B, we considered their hepatitis B vaccination status. The model assumes that 30% of health care workers received all three doses, 40% received two doses, 25% received one dose and 5% have not received any doses. Hepatitis B PEP is rarely used, although it is available if needed, and therefore is not included in this analysis. There is no immunization for hepatitis C and no recommended PEP for hepatitis C. The risk of infection for HIV, hepatitis B, and hepatitis C following a needlestick injury is 0.36%, 30% and 3%, respectively.²³

This research estimated the medical costs associated with the management of needlestick injuries based on the management protocols for PEP of HIV, as well as the treatment protocols for HIV, hepatitis B, and hepatitis C infections using data obtained directly from hospitals, pharmacists, and the DOH.

Prophylaxis after occupational exposure to HIV begins within one to two hours of exposure. The HIV status of both the injured person and the source patient is determined at the time of exposure. An HIV prophylaxis starter pack is given to all injured health care workers until their HIV status, and that of the source patient, is determined. Laboratory monitoring is done to exclude acquisition of HIV infection and for those given PEP to monitor toxicity. Testing for HIV infection is repeated at six weeks, three months, and six months.

Appendix C and Appendix D Tables D2 to D4 provide more detailed information on data sources and assumptions, including unit costs for the management of needlestick injuries and treatment of infections.

Sensitivity analysis

The research team conducted a one-way sensitivity analysis for the price of the retractable syringe to capture possible future costs, based on information obtained from suppliers in South Africa. The incremental cost of using retractable syringes is estimated for various prices by reducing the price of the retractable syringe by 10% to 50% of its current prices. In addition, the 2006 procurement price of the retractable syringe (US\$0.15 or 1.05 Rand) for the US-funded President's Emergency Plan for AIDS Relief (PEPFAR) project is included in the sensitivity analysis. A sensitivity analysis was also conducted for the percentage of reported needlesticks. Estimates from South Africa suggest that 64% of all needle sticks are reported. This analysis estimates costs for reported needle stick rates of 60% and 80%.

Cost-effectiveness analysis of unsafe injection in KZN and South Africa

The health benefits, costs, and cost-effectiveness of introducing retractable syringes were estimated for the province of KZN and for South Africa. This analysis examines the costs of introducing retractable syringes, as well as the number of infections and disability-adjusted life years (DALYs) averted for hepatitis B, hepatitis C, and HIV resulting from reducing both needlestick injuries among health care workers and reducing syringe reuse for curative and immunization injections among the general population. Syringe reuse is defined as using a syringe/needle on more than one person before discarding it. This can occur both in the health care setting, and within the population at large, with syringes found in trash, amongst injection drug users, etc. The incremental cost-effectiveness ratio of introducing retractable syringes compared to disposable syringes is calculated and defined as the ratio of the net change in health care cost over the net increase in health benefits between retractable and disposable syringes.

The risk to health workers of HIV, hepatitis B, and hepatitis C infection associated with a needlestick injury was calculated based on the decision-tree model developed for this analysis.

For KZN and South Africa, we also estimated the impact of retractable syringes on syringe reuse. No syringe reuse was observed during the evaluation, but for broader application of these findings, a sensitivity analysis was conducted using different syringe reuse rates. The estimate of the probability of infection from syringe reuse is based on the model by Alyward et al (1995), which demonstrates the risk of transmitting infection through unsafe injection practices as a function of exposure, susceptibility, and transmission. To estimate the impact of retractable syringes on reuse, these probabilities were applied to population-based data for KwaZulu Natal and South Africa. The model assumes an average of two injections per person per year and that 2% of these are with reused injection devices.^{iv}

The model assumes that 80% of all injections currently being given with disposable syringes would be replaced with retractable syringes. Hepatitis B vaccination was introduced into the national immunization program for children under one year in 1996 in South Africa. Nurses participating in focus group discussions conducted as part of this study indicated that approximately 30% of all health workers have received a full course of the hepatitis B vaccine, and approximately 40% have received at least two doses. The model assumes that 27% of the total population is vaccinated.

^{iv} Expert opinion from Robin Biellik, PATH. Former WHO advisor for immunization, southern Africa region.

A sensitivity analysis was conducted for the benefit of other countries in the region, and selected results are also reported for reuse rates of 5% and 7.5%. To assess the impact of retractable syringes on needlestick injuries, an additional category of health workers was examined: public-sector enrolled nurses, providing a more conservative benefit estimate. The model assumes that 100% of resulting infections are treated; however sensitivity analysis was performed for 50 and 75% of individuals receiving treatment. Appendix D Tables D4 through D6 provide detailed estimates for the cost-effectiveness analysis for KZN and South Africa.

For both of the above analyses, costs and outcomes associated with the impact of the retractable syringes are for a single year. All estimates are presented in 2006 Rand and US dollars. Future costs are discounted at an annual rate of 3%.

Findings

The assessment aimed to explore four areas regarding the use of retractable syringes:

- Acceptability of the retractable syringe device.
- Perceptions of safety using the retractable syringe.
- Effect on health facility waste disposal practices.
- Cost.

Data were collected from focus group discussions and individual interviews with health workers, waste handlers, facility supervisors, and key informants; observations of injection and waste handling practices; and an anonymous health worker questionnaire on needlestick history.

Findings from focus group discussions and individual interviews

Acceptability

The interview and focus group discussion guides (See Appendix A) included questions on ease of use, acceptability of the retractable syringes to health workers and waste handlers, as well as user compliance, training requirements, and acceptability of the syringes to patients as reported by health workers. Questions also explored respondents' experience with syringe availability and their impressions regarding the suitability of retractable syringes for different procedures.

Suitability of retractable syringes for different procedures

To determine the extent to which retractable syringes are used at the study sites, the moderator asked injection providers to list the procedures for which they used retractable syringes and to estimate how often retractable syringes were used. Clinic-based nurses reported using retractable syringes for IM injections, including immunizations, injectable contraceptives, and antibiotics. The nurses did not use retractable syringes for all IM injections, citing limited needle sizes and lengths as a problem. Respondents in half of the groups reported using retractable syringes for the majority of IM injections, and respondents in nearly all facilities reported using them selectively when the required needle sizes and lengths were available.

As in the clinics, hospital-based nurses used retractable syringes predominantly for IM injections. The majority of hospital nurses felt the retractable syringe was inappropriate for use with IVs because the needleless ports required the removal of the needle prior to injection. Usage

in the hospitals was proportionately lower than in the clinics; many nurses cited the limited need for IM injections in the hospital setting. The majority of hospital patients are treated intravenously or with oral antibiotics.

The nurses did not use retractable syringes to perform subcutaneous or intradermal injections, and with the exception of one or two clinics and hospital wards, they did not use the retractable syringes to draw blood. The needle sizes required for subcutaneous and intradermal injections were not included in the pilot study.

Ease of use and performance of retractable syringes

Respondents were asked about likes, dislikes, benefits, and disadvantages for the retractable syringe. All injection providers reported that the syringe consistently worked well and never failed to retract. Safety—specifically the prevention of needlestick injury—was the most common benefit reported among all three categories of health care worker respondents.

In addition to the retraction mechanism, several injection providers noted the inability to recap retractable syringes also added to the safety benefit. Although recapping has been removed from the injection protocol for safety reasons, a few injection providers acknowledged that they still recap needles, particularly when there is not a sharps container nearby.

The majority of injection providers and supervisors also reported “time savings” as a major benefit to retractable syringe use. When using a standard disposable syringe, the injection protocol in KZN requires the use of two needles: one needle to withdraw the medication, and a second needle to inject the medication into the patient. Nurses explained that the reason for changing the needle was to reduce pain and prevent cross infection. Nearly all injection providers reported that this procedure was time consuming and appreciated the speed of using the retractable syringe, however some were skeptical that the retractable syringe could use a single needle for injections without increasing injection pain.

In addition to the safety benefits, several waste handlers liked the fact that less waste is produced with the retractable syringe and that the sharps containers are slower to fill. Waste handlers also noted appreciation for a retractable syringe that prevents reuse.

Sample responses regarding ease of retractable syringe use:

“There’s less risk of needlestick injury because there’s not a needle once you’ve injected, you don’t have to recap, and with the sharps container...it doesn’t get full quickly. So I think it’s cost-effective in that way. And also it’s [not] time consuming because you don’t have to change the needle and stuff like that, like the disposable needles.” [Clinic nurse]

“There’s no recapping...with the old one—even if you were saying no recapping—there will still be that tendency..” [Clinic supervisor]

“What I like... is that we feel safer. Everything is inside and hidden. We can seal containers easily, and there is no more overfilled...” [Clinic general assistant]

When asked what injection providers disliked about the retractable syringes and any problems associated with their use, the most common complaint was that the retractable syringe needle became blunted during insertion through the rubber top of the medicine vial. The degree to which this blunting concerned the injection providers varied; for some it was a minor concern, while others (the minority) expressed concerns about using the retractable syringe for this reason.

A minority of supervisors noted concerns about needle blunting—although to a lesser extent than the injection providers. One supervisor felt that the injection providers’ fears were imagined since they were accustomed to changing needles.

Several injection providers reported a fear of needle contamination and subsequent infection when using the retractable syringe because the needle used to withdraw the medication is also used to inject the patient. They mentioned that at times nurses forget to swab the vial cover with alcohol and were afraid that these germs could be introduced to the patient. None of the supervisors mentioned infection control as a potential problem associated with retractable syringes^v.

Other concerns expressed by a minority of injection providers—particularly those from hospitals—were that the retractable syringes could not be used with IVs or with catheters. A few nurses reported that they did not like the clicking noise made during retraction, because it makes the patients “jump” and obliges the nurse to explain how the syringe works.

Two supervisors noted that the retractable syringe can not be used to take blood. Both respondents reported that after the nurse has injected the blood into the collection tube the syringe “spills” some of the blood upon retracting.

Waste handlers did not report any concerns or problems with the retractable syringe.

Sample responses regarding needle changing practices:

“Initially there were complaints to say that this needle becomes blunt and then when you give an injection it’s not as sharp as it’s supposed to be. But when that was allayed, it sort of died down. So I think it was a perception, rather than being real.” [Hospital supervisor]

“One thing I wonder about is the sterility of the retractable syringe, when you withdraw from the vial and take it straight to the patient. We used to change needles.” [Medical hospital nurse]

Settings in which retractable syringes are most useful

All categories of health care workers were asked for recommendations regarding retractable syringe use. Respondents were first asked where they felt retractable syringes would be most useful with respect to procedures and locations. They were also asked how they would prioritize retractable syringe use if the supply was limited.

^v The perception that using a single needle for septum penetration and injection increases pain is likely a perceived phenomenon, as there is no evidence to suggest that using one needle causes increased pain or complications at the injection site. In an Australian study, 70 subjects who had received IM injections completed an independently validated pain scale. Half of the subjects received the injection via a fixed needle and half via the two-needle approach. There was no significant difference in perceived injection site pain in the two groups. Another group of researchers in the U.S. sought to determine if changing the needle on a syringe after drawing up diphtheria-pertussis-tetanus (DPT) vaccine and before injecting it would reduce local complications. Two hundred and twenty-three children received a two-needle vaccination, while 200 received a vaccination with a fixed needle. There was no significant difference in the occurrence of redness, swelling, or tenderness in parental measurements between the two groups. Similarly, there were no differences in the frequency of systemic side effects including fever, vomiting, anorexia, and crying. Researchers from both of these studies concluded that using two needles for each injection is unnecessary and recommended injection providers shift to the one-needle approach.

The majority of injection providers and supervisors felt that retractable syringes should be used for “all IM injections” given within clinics and hospitals. Clinic-based nurses and supervisors also suggested retractable syringes be used for immunizations and family planning injections—both require IM injections—and with psychiatric patients because they tend to have erratic movements. A few respondents also felt that retractable syringes would be useful for diabetic patients who must take their syringes home with them and have no proper means of disposal inside the home.

Several hospital-based nurses and supervisors felt retractable syringes were most useful in out-patient settings (because of the high numbers of injections given) and casualty departments (because of added safety and time-saving features).

Nearly all clinic-based waste handlers reported that retractable syringes should be used in the facility injection room. Other suggestions included use with tuberculosis patients, HIV patients, and diabetic patients. The majority of hospital-based waste handlers felt the retractable syringes were most useful in the out-patient department. Others recommended use in clinics (within the hospital setting) and casualty departments.

Sample responses regarding settings where retractable syringe use is most helpful:

“All facilities. Wherever they give injections, they need to have them.” [Hospital nurse]

“Where there are psychiatric patients, and where there are children. And in the emergency places like casualty, where they admit all kinds of patients.” [Hospital supervisor]

When asked how they would prioritize use of retractable syringes if the supply was limited, clinic-based nurses and supervisors overwhelmingly recommended using retractable syringes for immunizations and family planning injections. Nurses cited “erratic movements” and high HIV prevalence in infants as justification for using retractable syringes for immunizations and the high patient load as justification for family planning. Hospital-based nurses and supervisors recommended use in casualty and theatre, citing “time-savings and safety” as the top reasons for their selections. Others expressed that out-patient departments would be the best place for retractable syringe use. Several hospital-based supervisors noted that a retractable vacutainer, rather than syringe, would provide the greatest protection in the hospital setting, as nurses commonly take blood from HIV-positive patients.

Clinic-based waste handlers would prioritize use by limiting it to the injection rooms and to psychiatric and tuberculosis patients. Waste handlers in the hospital setting suggested the out-patient and labor wards.

Sample responses regarding priority settings for retractable syringes:

“I would then say casualty—where you’re doing your tetanus and family planning—and clinics. Definitely the first place I would cut down would be the wards. Unless it’s a TB ward, and you’re giving IM antibiotics.” [Hospital supervisor]

“That would be super, if they had that [retractable vacutainer] available at antiretroviral clinics, because they are taking blood every time they come in, to check CD4 counts and that. And that is a very high risk area. So the retractable vacutainer, that would be super, and that would cut down a lot because a lot of ours are from taking blood.” [Infection control hospital supervisor]

Needle sizes and syringe availability

Stock shortages of retractable syringes and unavailability of appropriate needle sizes were problems in most facilities. One clinic had no retractable syringe stock for over a month, and one clinic had been using retractable syringes for only one week. None of the other facilities had the full range of available retractable syringes in stock at the time of the evaluation; most facilities had three or four sizes in stock, and for the most part, nurses were unaware that other sizes were available.

Several nurses reported that the needle bore of the 5-cc syringe was too small for thick or oily medications such as penicillin and nur-asterite, while the bore size of the 3-cc syringe was too large for use on infants. Similarly, needle length was a barrier to usage; many clinics received 5-cc retractable syringes with 1-inch needles, rather than the standard 1½-inch needles. Nurses noted the 1-inch needle was too short for IM injections and feared it would cause abscesses in patients.

Effect of retractable syringe on health worker job satisfaction

Supervisors within the clinics and hospitals were asked if the introduction of retractable syringes at their facilities had affected health worker job satisfaction. The majority of clinic supervisors noted the retractable syringe improved health worker satisfaction because of its safety and timesaving characteristics. Some mentioned obstacles such as insufficient training and limited needle sizes. Hospital managers reported little or no improvement in worker satisfaction, citing the limited need for IM injections in hospitals and the presence of other sharps such as scalpels and suture needles.

The moderators asked injection providers and waste handlers if the introduction of retractable syringes had changed their jobs in any way. Nearly all of the injection providers reported that retractable syringes had increased job safety and decreased the amount of time spent on each injection. The exceptions were the injection provider and waste handler groups in one of the hospitals, who felt that retractable syringes did not have a notable effect on safety because in the hospital setting the majority of sharps injuries come from devices other than syringes. All of the other waste handler respondents agreed that the introduction of retractable syringes had made their jobs safer, and several mentioned the fact that they no longer find needles on the floor.

Sample responses regarding health worker satisfaction with retractable syringe use:

“Everyone, when we show them they like it more than this other old ones because it’s easy this one, you don’t have to take the needle to this one, you just draw the medication and then inject the patient. You don’t have to run around looking for needles, different sizes.” [Clinic supervisor]

“Yes, they feel safe, they definitely feel safe. [It affects] their morale, because at least they know they are not exposed.” [Hospital supervisor]

“Yes, you feel safer when you’re injecting and know that there’s less chance of pricking yourself or anything...it saves time as well.” [Clinic nurse]

Patient response to retractable syringe use, as reported by injection providers and supervisors

Injection providers were asked how patients reacted to the use of retractable syringes. The majority of nurses reported that while patients rarely say anything, many give nonverbal

responses such as “jumping” (in response to the clicking noise) and expressions of “shock” (in response to the disappearance of the needle). A few nurses noted that patients receiving injections in the buttocks were the least likely to say anything, whereas mothers observing immunizations were the most likely to comment. The most common verbal responses from patients, as reported by nurses, were “where’s the needle?” and “what was that noise?” Most nurses felt that it was beneficial to inform patients about the clicking sound and the disappearance of the needle prior to injection, but many admitted that they do not do so. They feel it is easier and less time consuming to wait until the patient asks.

Sample responses regarding patient reactions to retractable syringe use:

“Some of them do have that look. Although they sometimes don’t ask but you can see they want to ask “Where’s the needle?” One patient came back to the night staff...and asked about it and said “my child has been crying since they injected...where has the needle gone?” She didn’t see the needle, where it had gone to, and they started afresh telling her what happened, explaining the procedure.” [Clinic nurse]

“I was concerned first when you inject, thinking it would be more painful with you press the button, but it is the same thing with taking out the needle. But otherwise you watch the patient’s facial expression, and it’s still the same like when you’re injecting with the disposables.” [Hospital nurse]

A majority of supervisors reported that the retractable syringe did not affect patient satisfaction because patients were unaware that a safety device was being used. Most of the supervisors noted nurses should inform patients prior to the injection that a retractable syringe would be used, and several reported they instructed their nurses to do so.

Health worker opinion on value of retractable syringes

All respondents were asked if it was worth it for the government to spend more money on the retractable syringe, as compared to the standard disposable type.

Nearly all respondents—from both clinics and hospitals—felt that the government should spend more money on retractable syringes, but were reluctant to suggest how much more. Many stated that one cannot put a price on safety and peace of mind in the workplace. Others emphasized that it would be wiser to spend money on the prevention of needlestick injuries rather than on post-exposure prophylaxis and follow-up testing. The exception was one supervisor from a hospital, who felt that that money would be better spent on other safety devices, such as protective masks, safety jelscos, and dolphin-nose needles, which are more commonly used in the hospital setting.

Sample responses regarding the value of retractable syringe use:

“It is [worth it] because there are some other benefits, like the morale of the staff, which you cannot buy. You can’t put a price on that. And it makes the environment safe, they are much more beneficial. So even though they are more expensive, I think they are worth it.” [Hospital supervisor]

“All of us, we need to give ourselves, our heart to the patients. But now I cannot give the whole of me to the patient if I’m not 100% safe. For the retractable syringe to be expensive, but on the other hand I’m going to benefit and the patient is going to benefit, because how is

the patient going to benefit if I say I can't help this patient? If both of us are now sick, who's going to look after another person if I'm sick as well?" [Hospital supervisor]

Safety

Respondents were asked questions concerning the retractable syringe's effect on safety, including several questions on the occurrence and experience of needlestick injuries. These questions aimed to characterize attitudes and practices towards needlestick injuries and determine how retractable syringes influence their frequency. Data on needlestick history were gathered separately through an anonymous questionnaire.

Concern over needlestick injuries

The majority of supervisors reported that needlesticks are a source of great concern for health workers, specifically because of HIV/AIDS. All supervisors mentioned HIV as a source of concern, and only one mentioned hepatitis. Injection providers and supervisors were asked about hepatitis vaccine coverage among health workers; only a small minority of respondents had received all three of the required hepatitis B vaccinations.

Sample responses regarding concern about needlestick injuries:

"It's a big concern to all of us really, it's a big concern. Because you know nowadays – HIV, hepatitis B, all those diseases. So once you get the needlestick, so many things: emotional, psychological because you don't know what is happening. Even the status, you don't know the status of the patient. Maybe even your status as well. You might think you are free from these things, then find that you do have these diseases. It may go up to the stage, even family become involved. Say I'm married and I'm pricked by the needle of an HIV patient. Then my wife and other people would be effected. So really, we are very happy about the retractables. Definitely." [Hospital supervisor]

"I'd say 50–50. You've got those that are aware, and then you've got those that say I'm exposed so often and I'm probably positive anyway, so I'm not really worried, but they are more aware of it now." [Hospital infection control supervisor]

Causes of and reporting of needlestick injuries

Injection providers and waste handlers were asked a series of questions about needlestick injuries, including the frequency of needlesticks and when and where injuries are most likely to occur. Respondents in both categories reported that needlestick injury was not common but did happen from time to time.

In general, nurses were reluctant to offer an average number of needlesticks per health worker per year. A few respondents guessed an average of one injury per health worker per year. Respondents in one group (from a busy hospital casualty ward) felt that the number was closer to 50 needlesticks per nurse per year, with approximately 30% of those due to normal disposable syringes and the remaining 70% due to suture needles and IVs. Another hospital group reported that the facility averages between five and ten needlestick injuries each month, with many occurring in the linen room where a health worker might be distracted with tasks and leave the needle in the bed. Most waste handlers similarly reported that needlesticks were uncommon, but they knew of, or had seen, between three and four per year in their facilities.

Injection providers noted an array of instances when needle sticks were most likely to occur: patients' unexpected movements, needle recapping, taking blood, suturing, and putting up a drip. Carelessness and working hurriedly were also noted as instances where needlesticks were likely to occur. Several nurses stated that waste handlers are often injured by needles found mixed in with linens. Waste handlers noted that the most common times that they experienced needlestick injury were in the morning or other times when they were in a hurry to clean up, when cleaning table tops, when mopping, and when handling linens. Respondents noted several areas of the health facility where needlesticks were more likely to occur: casualty, children's and psychiatric wards; injections rooms, outpatient departments, and labor wards.

When asked which health workers were most at risk, nearly all injection providers cited nurses because they give the most injections, specifically enrolled nurses, as they give more injections than professional nurses. A few respondents mentioned people who are "new to the job" as being most at risk due to inexperience. Some supervisors and nurses also cited general assistants because they handle medical waste.

Procedure if injured, accessing PEP in facilities

The three groups of health workers were asked to describe their facilities' needlestick injury protocol. All facilities had a needlestick policy, and the policies were posted in most sites. All supervisors and nurses could cite the general steps to be followed in case of needlestick injury (See Appendix B).

In both districts, the protocol states that the testing of the exposed health care worker and all follow-up visits should take place at the central hospital; however, several clinic-based nurses believed the testing would be done at their clinic, and were wary of this approach. Some nurses believed they would have to travel to the hospital to access PEP, yet most of the clinics had starter packs on site (starter packs were observed in all but two facilities and were accessible day and night).

All waste handlers were aware that needlesticks are dangerous and should be reported, and many could cite some steps in the protocol such as washing the needlestick and going for counseling. However, several waste handlers were unclear about the testing procedure or the regimen of pills. Nearly all waste handlers were unaware of a written policy at their clinic regarding needlestick injury. Waste handlers at one site felt neglected by other facility staff and alluded to teaching new staff the procedures among themselves due to lack of formal orientation.

Reporting of needlestick injuries

Researchers asked injection providers, supervisors, and waste handlers if most health workers reported needlestick injuries, and, if not, possible reasons for the lack of reporting. All injection providers and supervisors agreed that many health workers do not report needlestick injuries. The vast majority of respondents felt that many health workers fear getting tested after a needlestick injury because they do not want to know their status or because of a lack of confidentiality in health facilities. Other reasons included:

- Already knows that s/he is HIV-positive.
- Fears stigma.
- Lacks information about the need to report needlestick injury.

- Wants to avoid the long follow-up procedure/process.
- Fears the side effects of antiretrovirals.

To improve needlestick reporting, respondents suggested better guarantees of confidentiality and education on needlestick risks.

Sample responses regarding reporting of needlestick injuries:

“I think a lot of the staff keep quiet because of the whole procedure that a needlestick involves. Also if they’ve got to go onto prophylactic treatment, the way it makes them feel, so I think there’s a lot of staff that feel, why bother?” [Hospital supervisor]

“I feel that it’s underreported...They are afraid of being tested and being hospitalized. Maybe some of them, if they prefer being tested they will be tested outside, out of the institution.” [Hospital supervisor]

“I think one of the hardest things to change is people’s attitudes, and that’s what needs to be changed. If we report it, it eventually ends up with a supervisor, and no one will trust...they’ll say ‘Oh I know that one and she won’t keep it confidential, so why must I bother.’ So there’s the whole confidentiality thing.” [Hospital nurse]

Conversely, the majority of waste handlers reported that health workers (specifically waste handlers) always report needlestick injuries. Respondents felt that waste handlers must report needlesticks in order to obtain help and to prevent HIV transmission. Fear of being accused of negligence was cited as a possible reason why waste handlers would not report needlestick injury. Others cited fear of testing, fear of taking antiretrovirals, and ignorance as reasons for not reporting.

Change in needlestick frequency due to retractable syringe

Nearly all injection providers and waste handlers noted needle-stick frequency decreased since the introduction of retractable syringes; waste handlers, in particular, were convinced of this. In sites where the retractable syringe had been used for less than a month, respondents expected needle-stick rates to decline with the use of retractable syringes.

Many respondents expressed feeling safer when using the retractable syringe—one exception was a hospital waste handlers group who felt that retractable syringes were not used enough to result in needle-stick reduction.

Sample responses regarding needlestick frequency with retractable syringes:

“Before, the number (of needlesticks) was higher. But with the use of these (retractable syringes) there is less. Less than if you use the other one (disposable syringe).” [Hospital nurse]

“Yes it has changed...because if the nurse uses this syringe the needle goes back inside the syringe. There is no exposed needle like before.” [Clinic general assistant]

Perceptions of safety among health workers

All clinic-based supervisors reported that retractable syringes had increased the level of safety of health care workers, citing a reduction in needlestick injuries for both injection providers and waste handlers.

The majority of hospital-based supervisors felt that the retractable syringe had improved the safety of health workers, but a few felt it was not used enough to produce a significant impact. Reasons cited for infrequent use of retractable syringes in the hospital setting included:

- Declining need for IM injections in the hospital since the majority of patients are given medications either orally or intravenously.
- Abundance of other sharps in the hospital setting, which continue to pose a threat to health workers.

Sample responses regarding health worker safety of retractable syringes:

“Yeah...it’s safer. Even maybe to the patient because some of the patients jump when you inject them.” [Clinic supervisor]

“I don’t know how much they are using them (retractable syringes) in the wards. When we did the audit, they said they are. But when you look in the sharps containers, they’re not. Most of needlestick injuries have not been due to injections. They’ve been needles in the waste, which have been IV needles...taking of bloods, and even the hemostat ones that are supposed to be safe—the finger pricks, and the suture needles.” [Hospital occupational health supervisor]

Willingness to treat HIV-positive patients

Nearly all respondents reported that nurses feel less anxious when using retractable syringes on HIV-positive patients. A few of the hospital-based supervisors mentioned that nurses very seldom give injections to known HIV-positive patients, whereas blood draws are the more common procedure. For this reason, respondents felt that the retractable vacutainer would have a greater impact than the syringe on nurses’ willingness to treat HIV-positive patients.

Sample responses regarding health worker willingness to treat HIV-positive patients:

“Actually, I’ve got myself in mind. Sometimes you doubt whether you’re going to inject a person who’s HIV [positive]. A person reacts differently when you give them an injection. Some they jump...I know that once the needle is inside, even if he jumps, its coming up, it won’t touch me.” [Hospital supervisor]

“Yeah, yeah, because there is no exposure now. So everybody is willing and happy.” [Clinic supervisor]

Waste handler and community safety

Waste handlers were also asked how the introduction of retractable syringes had effected their safety or the safety of other health workers in their facility. All respondents reported that the retractable syringe had improved safety for them personally, and many commented that it had effected the safety of the nurses as well. A few also noted that patients and the community also benefited from using retractable syringes.

Similarly, all of the injection providers and waste handlers, and the majority of supervisors, felt that medical waste was made safer since the introduction of retractable syringes.

Sample responses on waste handler and community safety:

“It has effected (safety) in a big way. When we collect sharps containers we feel safe because we know there are no more needles sticking outside a container which can prick you. Now I know that when I’m doing my job I’m safe and free.” [Clinic general assistant]

“We found that the number of needlesticks from waste reduced (after the introduction of the retractable).” [Hospital supervisor]

Waste management

Waste disposal system

Waste handlers at the clinics and hospitals were asked to describe the flow of waste in their facilities, from the point of syringe use to final disposal.

Clinics place sharps in standard, 10-L, round, yellow sharps containers; other hazardous waste is placed in red plastic bags; and nonhazardous waste is placed in clear bags. Once the sharps containers are full, a nurse or a waste handler closes the lid, labels the container with the clinic name, and places a seal over the lid. Some of the clinics use “waste cages” outside of the building to store full sharps containers and hazardous waste bags. In other clinics, full sharps containers were stored in cabinets, storerooms, and on shelves within the clinics. In a few clinics, the full sharps containers were stored within reach of patients, but all observed boxes were closed and sealed. A driver from the hospital would visit each clinic weekly to collect the medical waste. The waste handlers reported that occasionally the driver misses a pickup, and the clinic is left with large quantities of medical waste. Respondents noted concern because of the limited storage space available—and because of the offensive smell produced by the stored waste. The waste handlers were unaware of what happens to the waste after collection from the clinic.

The two hospitals participating in the evaluation were replacing the standard 10-L sharps containers with the Daniel SharpsSmart® containers. In contrast to the standard sharps container, the SharpsSmart container is reusable. When the SharpsSmart is full, it is collected by the waste management company, emptied of its contents, sterilized, and returned to the facility. Aside from the differing sharps containers, the hospital waste disposal system was similar to the clinics, (red bags for hazardous waste and clear bags for municipal waste). The hospitals store their own waste along with clinic waste in lockable rooms/cages on the premises.

All hospitals in KZN have a contract with Compass Waste, a private medical waste management company. Compass supplies all sharps containers and medical waste bags and collects medical waste from the hospitals several times per week. Compass treats and disposes of all medical waste produced in KZN government facilities.

Problems with current waste disposal system

The interviewer asked waste handlers if they ever found used needles outside of the sharps containers and if the sharps containers ever became “over-full” with needles sticking out. Nearly all waste handlers reported occasionally finding needles outside the sharps containers. Clinic staff reported predominantly finding needles on the floor, while hospital staff found needles on the floor, in bed linens, and inside the red hazardous waste bags. Waste handlers reported rarely seeing “over-full” boxes and noted that most nurses respect the “full line” on the boxes and do not overfill. A few waste handlers reported that the overfilling problem was solved by using larger boxes (10 L instead of 5 L).

Changes in waste management due to retractable syringe

All three categories of health workers were asked how retractable syringes were disposed of, compared to normal disposable syringes. All reported that retractable syringes were disposed of in the same manner as standard disposable syringes (e.g., placed into a sharps container after use). A few nurses commented that it seemed unnecessary to dispose retractable syringes in this manner, since the needle is retracted and poses no injury threat. They felt that disposing of retractable syringes in the red plastic bags would be sufficient. One hospital supervisor also acknowledged this possibility, but felt it was best to stick with one policy for the disposal of all syringes, so as not to send mixed messages to the staff.

When asked about the impact introducing retractable syringes had on the quantity of medical (sharps) waste produced in facilities, the majority of respondents believed that the retractable syringe resulted in less waste (compared with) disposable syringes) syringes with retracted needles took up less space in the sharps container.

Sample responses on waste management with retractable syringes:

“(Now) those containers, they don’t get full easily, because the needle goes back and you only discard the syringe.” [Hospital supervisor]

“The needle just takes too much space inside the container it would take more retractables to fill that box compared to the old type.” [Clinic supervisor]

Training in retractable syringe use

Injection providers and supervisors were asked to describe the training they received and to offer recommendations for future training sessions.

The training approach differed in the two districts. In one district, the supplier held training workshops at the central hospital and a representative from each of the surrounding clinics was invited to attend. The onus was then on the representative to train clinic colleagues. One district clinic was unable to send a representative (due to staffing issues) and consequently no one from that facility received formal training.

Many nurses reported teaching themselves how to use retractable syringes, or being taught by a nurse who had used them at another facility. In the facilities able to send a representative, some nurses reported that the representative did not provide relevant training to staff. Many supervisors and nurses from these facilities stated that although learning to use the retractable syringe was easy, they would have preferred an in-house training session to observe the demonstration and have a chance to ask questions. Conversely, the respondents from the hospital were, for the most part, satisfied with the training they received and the hospital has incorporated a retractable syringe demonstration into its new employee orientation. Consequently, all new staff, including waste handlers and administrative workers, receive training.

In the other district, the supplier sent a representative to each clinic and to various hospital wards to demonstrate use of the retractable syringe. Some clinic staff had also attended a district-level workshop where the retractable syringe was discussed. Both hospital and clinic-based nurses appreciated the in-house training but felt the content too limited because the syringe was not demonstrated on a patient. In addition, many of the nurses and supervisors would have liked detailed information and discussion on the available sizes (both for the syringe and the needle) and recommendations from the representative about what sizes should be used with various

procedures. Two of the hospital supervisors recommended offering a training session every six months to ensure that both new and current employees receive training in retractable syringe use.

Sample responses regarding training:

“In my personal opinion (the training) wasn’t (enough) because...he just started saying “it’s easy you pull, the needle retracts. It wasn’t actually demonstrated on the client.” (Clinic nurse)

“Someone should come and demonstrate to us on every aspect...for example how to use it if you are giving IM, IV, and all those things, not just withdrawal.” (Hospital nurse)

“That’s why I think it is wise to have those people coming. Because they can even tell us, ‘if you want to do this procedure, its better you use the 3 cc...or its better maybe for me to use that [sized] needle’. But now we are using our own discretion.” (Hospital supervisor)

Supervisors were asked about expected problems if training did not occur prior to the introduction of retractable syringes into a facility. Several supervisors related stories of untrained nurses panicking following the retraction of the needle. In two instances patients were rushed to Xray to determine if the needle was “stuck” in the patient. Supervisors also noted that many syringes would be wasted if nurses were expected to use them without being trained. Supervisors felt that introducing the retractable syringe without training would be unacceptable.

Effect of insufficient training on retractable syringe usage

Several nurses and supervisors reported insufficient or no training as a barrier to retractable syringe use at clinics and in certain hospital wards. The injection providers in one hospital ward reported that retractable syringes had been in stock for several months before they started using them because staff had not received training. They began using them only after the supplier’s representative visited the ward. A few supervisors felt that lack of knowledge about available sizes impedes retractable syringe use and creates a negative impression about the syringes.

Sample responses regarding insufficient training:

“We didn’t get any in-service about them so we had no information. So we were using the old ones instead.” [Hospital nurse]

“Many times I was questioning the wards why they are not ordering [retractable syringes] and I would send them the retractable. They would say, ‘we don’t have the syringes.’ And I would say, ‘but we’ve just sent you so much of the retractable syringes.’ And they would say ‘but we can’t use those’....Most of them were not inserviced about them. They were not sure how to use them. That’s why there was an issue about them shortly after that.” [Hospital supervisor]

Findings from observations of injections

One member of the research team observed an average of five injections at each facility following approval from the nursing manager. The type of syringe used was at the nurses’ discretion. The observer noted the type of syringe used (disposable versus retractable) and why; the type of injection (IM, intradermal, subcutaneous, or push-IV); and the reason for the injection.

When a retractable syringe was used, the observer recorded:

- If the syringe was retracted properly while the needle was still in the patient's arm.
- If the patient was informed of retractable syringe use prior to the injection (clicking noise and needle disappearance).
- Patient reaction (verbal or physical).
- Type of syringe disposal method.

Each injection—retractable or disposable syringe—was timed, and results were used in the economic evaluation.

Observations of retractable syringe use

A total of 52 injections were observed, 32 used a retractable syringe and 20 used a disposable syringe. One clinic did not have retractable syringes in stock and consequently used only disposable syringes. IM injections were such a rare occurrence at one hospital that only one injection was observed at that site. In three facilities, the nurse opted to use retractable syringes for all injections; usage was mixed in the remaining facilities. All injections were intramuscular, and the reasons for injection were predominantly family planning and immunization. Other indications included sexually transmitted infection, tuberculosis, and psychiatric treatment. Needle size was the main reason cited for choosing a disposable syringe instead of a retractable syringe. Nurses commented that the available retractable needles were too large for some immunizations and too small for certain thick medications. One nurse opted to use disposable syringes because she was concerned about blunting of the retractable needle.

When using a retractable syringe, all observed nurses retracted the needle properly. None of the nurses informed the patient of the impending clicking sound or needle disappearance. The majority of patients had no visible reaction to the injection, either verbal or physical. None of the patients commented on the noise or the disappearance of the needle. A few children frowned; however, a similar response was noted with children injected using disposable syringes. Retractable syringes in all facilities were disposed of in sharps containers.

Findings from needlestick questionnaire

Researchers distributed Zulu and English versions of the anonymous questionnaire (Appendix A) to health workers at the beginning of each site visit. Staff were informed that completion of the questionnaire was voluntary and to return it to the locked box by the end of the day. The questionnaire captured the following information:

- Facility type (hospital versus clinic).
- Individual's job/role at the facility.
- Length of time using retractable syringes.
- Number of needlestick injuries received in the past 12 months and circumstances of their most recent needlestick injury.
- PEP receipt with reported injuries.

- Factors deterring health worker reporting of needlestick injuries and suggestions for encouraging needlestick reports and PEP.

A total of 146 questionnaires were returned from the 10 facilities, with 87 responses from hospitals, and 59 from clinics. The majority of submissions came from injection providers (75), followed by waste handlers (25), and supervisors (22). The remaining respondents either held other positions such as counselor or clerk, or did not answer the question.

Ten percent of the respondents (15/146) indicated that they had experienced a total of 25 needlestick injuries in the past year. Injection providers reported the majority of needlesticks, followed by waste handlers. “Unexpected patient movement” accounted for many (6 of 15) of the reported injuries. Other reported injuries occurred during needle recapping, clean up/waste collection, and collision with a coworker. Four individuals reported being injured by a retractable syringe. One was injured while inserting a cannula, another due to unexpected patient movement. The other two offered no explanations.

Of the 15 respondents who reported experiencing a needlestick injury in the past year, eight reported the injury to a supervisor. Reasons for not reporting included “did not want to take HIV test” (3), “too busy/didn’t have time” (3), and “I get an HIV test every 6 months.” Of the eight individuals who reported the injury, six received PEP. One of those who didn’t receive PEP reported being afraid of the side effects; the other offered no explanation.

Ninety-two respondents provided suggestions of what might inhibit a person from reporting a needlestick injury. The majority (49) of respondents selected “employee doesn’t want to take HIV test” as the main reason for not reporting. Other reasons included “employee doesn’t want to admit stick to supervisor”(6); “employee is not concerned with needlestick”(6); and “employee doesn’t know s/he is supposed to report”(5).

Finally, 73 respondents provided suggestions for encouraging the reporting of needlestick injuries. The most common suggestions included “having a confidential place to report the injury” (16); “having more information on the importance of reporting” (15); and “having more information on the risks of needlestick injuries” (14).

Findings from key informant interviews

Researchers asked two provincial-level DOH employees a series of questions regarding retractable syringe introduction in selected facilities. Both respondents were involved in the initial decision to order retractable syringes and to conduct the DOH pilot study monitoring the impact of retractables within the facilities.

Decision to order retractable syringes

The interviewer asked the respondents why the DOH decided to introduce retractable syringes in 2004, and what factors were taken into account during the deliberation process. Both respondents explained that the DOH was concerned about high needlestick injury statistics from some of its facilities and wanted to implement a system to protect its employees. The Vanishpoint® retractable syringe was the only safety syringe available at that time in South Africa, leading to its selection. Key informants reported that cost and safety were the main factors considered. Cost was a concern, but funds were made available because of the conscious commitment by the DOH. In 2004, a DOH pilot study including one hospital from each district (the hospital with the

highest number of reported needlestick injuries) examined the impact of retractable syringes on needlesticks.

When asked if the decision to order retractable syringes was difficult to make given their high cost, both interviewees replied that it was not a difficult decision. They explained that there was a great deal of political will within the KZN DOH, which helped to ensure the funding of the pilot study. The funds were made available at the provincial level, and since the pilot study ended in mid-2006, hospitals have been responsible for ordering retractable syringes and paying for them out of their own budgets.

One respondent explained that prior to the beginning of the financial year, each hospital submits a budget proposal to the head office. Assuming each item is properly justified, the funds will be released from the provincial treasury.

Benefits and problems associated with retractable syringe use

The respondents were asked if they had seen any benefits or advantages within the facilities using retractable syringes. Both felt strongly that the retractable syringe conferred safety benefits. One respondent replied that the statistics have shown a decrease in the number of needlesticks, as well as a decrease in the number of compensation claims. The average annual number of needlestick injuries at one of the participating hospitals prior to the introduction of retractable syringes was 23; following the introduction of retractable syringes, the average has been 3 per year. Similarly, the other respondent noted that there have been no reported injuries from retractable syringes.

When asked about problems related to retractable syringe use, one respondent noted there had not been complaints. The other respondent explained that while there have been no real problems, the introduction of the syringes and the subsequent training is an ongoing process that takes time.

Recommendations for use and health worker response to retractable syringes

The interviewer asked the key informants where they felt retractable syringes should be used if funds were limited and unlimited. Both respondents felt that retractable syringes should be available in all facilities; however, both declined to suggest how to prioritize retractable syringe use with limited funding. One respondent explained that no facility or group of health workers deserves retractable syringes more than another.

When respondents were asked how health workers reacted to the introduction of retractable syringes, one noted, "It has motivated workers because they feel secure, safer. It has improved morale."

Future plans

Finally, the respondents were asked about the DOH decision to introduce retractable syringes and future provincial and national use. Both reported being pleased with the decision to introduce retractable syringes because of the effect on health care worker safety and morale.

Based on the positive results of the pilot study, the province intends to introduce retractable syringes into all of its health facilities. All facilities in KZN are now able to order retractable syringes should they choose. Both respondents felt that retractable syringe use for IM injections should be incorporated into provincial policy but were reluctant to discuss national policy. One

respondent emphasized the fact that the KZN DOH is interested not only in retractable syringes, but in all medical safety devices; the DOH aims to have numerous safety devices on the tender for health facilities.

Sample responses on future plans for use of retractable syringes:

“We won’t limit ourselves to Vanishpoint®. We want competition, to ensure good quality and lower prices. We want facilities to be able to choose from different products and suppliers, based on marketing, good service, cost, and user-friendliness.”

Findings from economic evaluation

Incremental costs in study facilities

The incremental cost of using retractable syringes is R2.60 per injection (Appendix D, Table D1). This increased cost of using retractable syringes is slightly offset by some small savings in waste disposal costs and personnel time per injection. For the representative hospital in this study, 441,984 injections were given in 2006; if all injections were provided with retractable syringes, the total incremental cost would be R1,148,686. In the clinic setting—which gives an average of 3,918 injections per year—the total incremental cost is R10,183 per clinic.

Cost analysis of needlestick injuries (assuming no syringe reuse)

The two main components of unsafe injections are needlestick injury and syringe reuse. All autodisable syringes (including retractables) eliminate syringe reuse, but only retractable syringes have the additional value of reducing needlestick injury. Therefore, the first step of the cost analysis looks only at the impact of retractable syringes on reducing needlestick injury. This analysis is based on estimates of needlestick injuries calculated from the number of health workers at representative study facilities in the KZN evaluation and from estimated PEP, and HIV, hepatitis B, and hepatitis C treatment costs associated with the typical management protocols.

Needlestick injuries attributable to injections with disposable syringes totaled 81 in the study hospital and an average of less than 2 in the study clinic (1.16). Syringe reuse was not measured, reported, or included in this portion of the analysis.

The average cost of treatment per reported needlestick injury is R2,612, using the assumption that only 60% of health care workers report their injuries and receive PEP treatment. For the hospital, the total medical costs averted are R210,763 per year. In the clinic, the total medical costs averted are R3,019 per year. These estimates include the average lifetime HIV treatment cost per health care worker with reported needlestick injury.

The total net cost of introducing retractable syringes in the hospital setting is R937,923 which is equal to the total incremental cost of using retractable syringes minus the direct medical costs associated with treating needlestick injuries (Appendix D, Table D2). The average cost per additional retractable syringe is R2.12 per injection in the hospital and R1.83 per injection for the clinic setting.

Although our model assumed a 60% needlestick reporting rate and assumed 135 actual needle sticks, the true number of needlestick injuries could have been significantly higher. This study considered only nurses and did not collect data on injuries among waste handlers, laundry

workers, and other hospital staff who are also at risk of needlestick injury. To explore the uncertainty around this variable, an estimate was made of the number of needlestick injuries required for retractable syringes to be a cost-saving investment through averting the costs of needlestick management and associated treatment costs of HIV, hepatitis B, and hepatitis C. This break-even point is achieved when the annual number of needlestick injuries among all health care workers is 741 instead of 135 (Appendix D, Table D3).

The current South African price of the retractable syringe is R3.25 (US\$0.42). As the syringe is introduced more widely and in higher volume, the price is likely to drop significantly. At the current reported needlestick rate, the break-even price of the retractable syringe would be approximately R1.00 each. There is evidence that the price can be reduced to the break-even point since the same syringe is procured in a high-volume international tender for the US-funded PEPFAR program for US\$0.15 or R1.05 per syringe. At this cost, retractable syringes are almost cost-neutral and come close to offsetting the costs of PEP and treatment for HIV, hepatitis B, and hepatitis C.

Cost-effectiveness analysis of unsafe injection in population-based estimates for KZN and South Africa (assuming needlestick and varying levels of syringe reuse)

Although reliable data on actual rates of syringe reuse in South Africa are not available, this portion of the cost analysis added the assumption that 2% of syringes are reused. WHO reports a rate of 17% syringe reuse for sub-Saharan Africa, but South Africa has high injection safety standards and therefore a significantly lower rate of reuse. We also assumed health workers received 2.1 needle sticks per year—32% of which are attributable to injections and could be eliminated by use of retractable syringes.²⁴

Because the retractable syringe prevents reuse and reduces needlestick injury, our model shows the introduction of retractable syringes could avert 3,823 hepatitis B, hepatitis C, and HIV infections caused by unsafe injections in KZN and 18,426 infections in South Africa. The majority of these cases are hepatitis B (93%), followed by hepatitis C (3.6%), and HIV (2.4%).^{vi} If the estimate of syringe reuse is increased to 5%, nearly 15,000 infections would be averted in KZN and over 65,000 averted in South Africa by using retractable syringes (Appendix D, Table D4).

Based on the current price of retractable syringes in South Africa, the total cost of using a mix of disposable syringes (20%) and retractable syringes (80%) is equal to R49,232,700 in KZN and R237,212,100 in all of South Africa. The total medical costs averted—including both the management of reported needlestick injuries and the costs associated with treating all cases of hepatitis B, hepatitis C, and HIV infections—is R58,407,059 in KZN and R243,473,104 in South Africa (Appendix D, Table D6). When the reduction in medical treatment costs is taken into consideration, the introduction of retractable syringes is a cost saving for both KZN and South Africa.

^{vi} Relatively few of these total infections are attributable to needlestick injuries in KZN and South Africa. For private- and public-sector enrolled nurses, who provide the majority of all injections, retractable syringes would avert a total of seven hepatitis B, hepatitis C, and HIV infections from reported needlestick injuries and a total of 22 infections in South Africa.

If treatment rates fell to 50%, the incremental cost savings diminish and there would be a small incremental cost per safe injection (R0.24 in KZN and R0.47 in South Africa). However, even at the 50% treatment level, retractable syringes remain cost-effective with the cost per-DALY-averted for HIV infections equal to R4,828 per-DALY-averted in KZN, and R9,251 per-DALY-averted in South Africa. Using standards set in the 2002 World Health Report, interventions with an incremental cost-effectiveness ratio (\$/DALY) less than the per capita gross domestic product (GDP) are considered very cost-effective and those less than three times the per capita GDP are considered cost-effective.²⁵ The average GDP for KZN was R4,563 and for South Africa, it was R5,916 in 2006.

As discussed in the previous section, if the price of the retractable syringe drops as volume increases, the cost-effectiveness of the retractable syringe will be further increased.

Discussion

Retractable syringes are an effective means to reduce the transmission of HIV and hepatitis B and C that occurs due to injection-related needlestick injury among health care workers in South Africa. Nearly all respondents believed that the retractable syringe made their jobs safer, and many reported that the frequency of needlestick injury decreased since the syringe's introduction. This reduction in needlesticks was confirmed by the provincial-level key informants who collect statistics on needlestick injuries.

The importance of needlestick prevention cannot be overstated. While all facilities had a needlestick reporting system in place and a starter pack of PEP available on site, focus group discussions and anonymous questionnaires found that the majority of needlesticks go unreported. Fear of testing, perceived lack of confidentiality, fear of stigma, and lengthy follow-up procedures deter health care workers from reporting injuries and receiving proper follow-up care. Waste handlers, in particular, lacked information on the testing procedure and policies regarding needlesticks. Also, the majority of respondents were not fully vaccinated against hepatitis B—a disease at least 10 times more infectious than HIV. Despite insufficient immunization, many nurses reported that hepatitis B was not a big concern.

The majority of respondents—and waste handlers in particular—believed that retractable syringes made medical waste handling safer. Waste handlers reported finding fewer needles on the floor, in bed linens, and sticking out of sharps containers. Several nurses and waste handlers also believed that using the retractable syringe improved community safety.

Despite KZN DOH use of a private company to manage its medical waste, community safety from sharps waste is not guaranteed. In January 2007, the South African Broadcasting Corporation (SABC) reported the dumping of medical waste, including used syringes and bandages, in a landfill in Msinga District of KZN.²⁶ Children came across the used syringes while playing at the dump site. The source of the waste was not identified. A similar illegal dumping incident occurred in the Western Cape Province in 1999.²⁷ Fifty-four children received needlestick injuries from used needles and syringes that had been dumped on their soccer field. The children gave one another injections and played darts with the discarded needles. If the discarded waste included retractable rather than disposable syringes, both communities would have been protected against injury.

Hospitals demonstrated a need for safety devices in addition to retractable syringes. The perceived impact of retractable syringes on safety was less pronounced in the hospital setting. Syringes are used for dozens of different procedures in hospitals, many of which require the flexibility of a standard disposable syringe. Hospital-based health workers are continually exposed to a variety of sharps and report that the retractable syringes have a minimal impact on their day-to-day safety. Many hospital-based nurses and supervisors mentioned the need for more safety devices for hospital settings: safe phlebotomy devices, dolphin-nose needles, and needleless IV ports.

Despite the favorable response to the retractable syringe, many facilities reported minimal usage primarily because of limited supplies and insufficient training. The limited needle sizes precluded the use of retractable syringes for many injections. Injection providers were inclined to use standard disposable syringes due to insufficient training on using retractable syringes.

Stemming from the habit within KZN facilities of using two needles for each injection, one concern reported with retractable syringe use was inability to change the needle after drawing the medication. Nurses reported being taught to change needles between drawing a dose and giving an injection to protect the patient from pain and infection; consequently, concerns over patient comfort and safety are to be expected with the fixed-needle retractable syringe. However, in two independent studies in Australia and the U.S., researchers found no significant difference in pain levels or adverse effects (abscess, fever, crying, or injection-site tenderness) associated with injection between fixed-needle and two needle injections.^{28, 29} Changing needles is not a WHO recommended practice.³⁰

The majority of injection providers did not inform patients when a retractable syringe would be used for an injection, citing limited time and perceived patient ignorance or lack of interest. However, several nurses credited government-sponsored radio campaigns for increasing community awareness about the dangers of needle reuse. Consequently, introducing the retractable syringe to patients would appear to be an opportunity to improve patient satisfaction by assuring them of high injection standards. Also, failing to inform patients of retractable syringe use could lead to confusion and fear, as some patients are surprised by the disappearance of the needle and suspect it has remained inside the body. This confusion could be avoided by a brief discussion about the retractable syringe.

Overall, response to the retractable syringe was favorable. Injection providers and supervisors appreciated the syringe's safety and time-saving characteristics. Supervisors, particularly those from clinics, noted that using retractable syringes had improved health worker job satisfaction and had a positive effect on morale. Decision-makers felt the safety and morale benefits provided by retractable syringe use were worth the higher purchase price of the device, even without evidence of its cost-effectiveness in reducing HIV transmission. They plan to continue use of the retractable syringe throughout KZN province. However, this is unclear for other South African provinces.

The cost analysis revealed several important variables impacting the cost-effectiveness of the retractable syringe. Since this model used conservative estimates for needlestick rates, needlestick injury resulted in a relatively low number of HIV infections prevented. Therefore introduction of the retractable syringe results in a large net cost increase if only needlestick injuries are considered. However, if even a low rate of 2% syringe reuse is added to the equation, the retractable syringe becomes cost saving.

If the price of the retractable syringe is reduced, the use of retractable syringes becomes more cost saving. It is reasonable to expect the price to drop as volumes increase. The price of the same syringe has already dropped to about one-third of the South African price when purchased in large volumes through the PEPFAR project which procures syringes for 15 African and Caribbean countries.

The use of higher needlestick injury estimates would also increase the calculated cost-effectiveness of retractable syringes. Obtaining accurate information on the actual number of needlestick injuries was a challenge in this analysis; ultimately, the cost model relied on estimates of needlestick injuries per health care worker based on WHO regional data. Assuming syringes are not reused and the current price of the syringe remains high, retractable syringes would be a cost-saving investment for the hospital in this study if there were approximately 750 needlestick injuries per year instead of the 135 estimate used in this analysis. This implies that health care workers would have to receive close to four needlestick injuries per year, a number that may be realistic since underreporting of occupational injuries was widely acknowledged among health care workers interviewed in this study.^{31 vii} In addition, our estimates were based on needlestick injuries for nurses alone and did not include other health care workers at risk of occupational hazards. For example, waste handlers, though not included in the needlestick estimates in the cost model, reported receiving fewer needlestick injuries once retractable syringes were introduced.

These economic costs do not reflect less tangible—but equally real—costs such as the loss of trained health workers from illness and premature death, lost earnings, morbidity due to side effects of anti-retroviral drugs, effect on health worker morale, willingness to treat HIV-positive patients, impact on recruitment of health care workers in high HIV-prevalence environments, counseling, potential medical discrimination, and potential litigation. As HIV levels increase, the risks increase for those treating HIV-positive patients.^{32, 33}

This study does not want to imply that retractable syringes are the only solution to injection safety. Technology introduction alone should not be considered a complete response to injection safety concerns. However, when combined with a high-level commitment to health worker safety—including improved procedures, training, and supervision—technologies can provide an additional degree of safety. Additionally, alternative syringe technologies exist with some of the same safety features as retractable syringes. Autodisable syringes are a lower-cost means of preventing syringe reuse. They are recommended by UNICEF for use in all immunization programs. By comparison, retractable syringes—which also prevent reuse—have the added benefit of reducing needlestick injury and several potential indirect benefits including improved health worker acceptability, simplified waste handling, reduced community exposure to infectious sharps waste, and greater health worker willingness to treat HIV-positive patients.

Recommendations

Several policy-level steps would improve health worker safety and injection safety in South Africa:

^{vii} This is equivalent to 445 reported needlestick injuries, or approximately 2.1 reported needle sticks per health care worker, given that approximately 60% of health care workers report their injury.

- Confidential systems and a supportive climate for reporting needlestick injuries will encourage all health workers to report injuries and receive treatment. Nursing organizations have an important role to play in advocating for improved awareness of the risks of unsafe injection including needlestick injury and for improved policies and safety standards.
- Safety devices should be procured for all procedures that use sharps, prioritizing procedures where the risk of bloodborne pathogen transmission is highest, such as IV needles and phlebotomy sharps.
- Policies and legislation aimed at protecting the safety of health workers and patients to unsafe injections will be essential for ensuring widespread use of safety syringes and for reducing prices.¹ Such policies would be expected to catalyze support for the public and private sectors to work together to create a sustainable supply of affordable safety syringes in South Africa.
- Introducing retractable syringes into public and private health care settings would be beneficial in reducing the consequences and costs—direct and indirect—associated with both reuse and needlestick injuries. To build upon lessons learned during the retractable syringe introduction in KZN, the study recommends the following steps to ensure more effective use of retractable syringe in the future:
 - Supplies: Ensure a full range of retractable syringe sizes is always available at each facility. Assess all procedures where sharps are used, particularly those with high risk for bloodborne pathogen transmission, and identify safer products (needleless IV ports, dolphin-nose needles, and safety jelcos).
 - Use: Use retractable syringes for all IM injections in all health facilities. If funds are limited, prioritize clinics over hospitals; infants, children, and psychiatric patients (due to unexpected and erratic movements); diabetic patients (who must take syringes home and have no safe means of disposal); HIV wards (due to high HIV seroprevalence); and outpatient and hospital casualty departments (due to high patient load and stressful working conditions).
 - Training: Conduct training at the facility level rather than at a central training site. Modify the current training agenda to include an explanation of the available sizes of retractable syringe/needle and instruction on which size syringe and needle to use for different medications and patients. Include demonstration of retractable syringe use on an actual patient in training sessions. Post the manufacturer’s wall chart indicating which size syringe to use for various injections at all facilities using the retractable syringe. Include waste handlers in training on retractable syringes.
 - Health worker safety: Improve health education for all health workers, including managers, on needlestick prevention, risks, and the importance of reporting needlestick injuries. Improve both confidentiality and quality of information surrounding the management of needlestick injuries, in order to improve the rate of reporting and to ensure health worker access to PEP. Increase awareness regarding hepatitis B virus and the importance of complete hepatitis B vaccination for health workers.

- User perceptions: Address nurses' practice of using two needles per injection during training and through supervision. Make health workers and supervisors aware of the studies that show no difference in injection pain when comparing a single needle to using two separate needles to dose and deliver the injection.
- Patient perceptions: Inform patients when using retractable syringes, both to illustrate high injection safety standards and to avoid confusion following the disappearance of the needle.
- Reinforce best practices: Provide supportive supervision to ensure safe injection practices and proper use of retractable syringes after the training period.

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Appendix A—Data Collection Tools

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Informed Consent for Evaluation Participants

Evaluation title: Evaluation of Retractable Syringes in Immunization and Curative Settings in KwaZulu Natal, South Africa

Purpose of the evaluation

Good afternoon. The KwaZulu Natal Department of Health (DOH) and PATH, a non-profit international health group based in the U.S. with an office in South Africa, are doing research on the acceptability, perceived safety, and cost-effectiveness of using retractable syringes in curative and immunization settings. The DoH has already introduced retractable syringes in some hospitals and clinics in this province. We are inviting health workers, injection providers, supervisors and waste handlers in clinics, community health centers and hospitals in KwaZulu Natal to take part in this evaluation.

Procedures

Because your workplace provides curative and/or immunization injections using retractable syringes, you are being invited to take part in this evaluation. If you decide to take part in this evaluation, we may ask you to do the following:

- Participate in a one-hour, in-depth interview, or
- Participate in a 90-minute focus group discussion, and/or
- Allow the evaluation team to observe you on the job during a visit to your facility.

Interview and focus group discussion topics include experience with and attitude toward the retractable syringe, attitude toward and recommendations concerning needlestick injuries, and experience with medical waste disposal at your facility.

The focus group discussions and interviews will be tape recorded to help us capture all of the information discussed. The tape recording will be destroyed after the information is transcribed onto the computer, within one month of the focus group discussion or interview.

Benefits

What we learn from the evaluation will be reported back to the KwaZulu Natal and South African DoH and to others who are interested. What we learn may help to make injections and sharps waste disposal easier and safer in South Africa and elsewhere. There is no cost to you to participate.

The results of this evaluation will be made available to all participants after data collection and analysis have been completed.

Risks

What you say in any focus group discussion could potentially be repeated by another group member. You may experience stress from discussing issues related to needlestick injury.

Confidentiality

Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Although focus group participants will be instructed to respect each other's privacy and anonymity, what you say in a focus group discussion could potentially be repeated by another group member. Participants will be instructed not to reveal the identities of other group members, nor to indicate who made specific comments during the discussion.

Your name will not be put on any data collection forms or on any papers written about this evaluation. Your clinic will have a number that is only known by the PATH evaluation monitors who will be managing this evaluation. The University of Witwatersrand Research Ethics Committee may inspect and/or copy your research records for quality assurance and data analysis. The evaluation data may be used by other researchers in the future.

Leaving the evaluation

Participating in the evaluation is your choice. You are free to leave the evaluation at any time. There will not be any problem for you or for your job if you do not want to be part of this evaluation, or if you join the evaluation and then decide to stop.

Need for more information

If you feel you need more information about this evaluation, you can contact:

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PATH
34 Second Avenue
Melville, 2109
Johannesburg, South Africa
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Email: mfolson@path.org

If you want to know more about your rights as someone taking part in an evaluation, or if you wish to report any concerns, you may contact the University of the Witwatersrand Human Research Ethics Committee:

Tel: (011) 717 1234
Fax: (011) 339 5708
E-mail: keshava@research.wits.ac.za.
Chair: Professor Cleaton-Jones:
Tel: (011) 7172229
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You may also contact the head of the PATH Human Subjects Protection Committee:

Nancy Hathaway
PATH
1455 NW Leary Way
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Tel: 1-206-285-3500
Fax: 1-206- 285-6619
Email: nhathaw@path.org.

You may also ask Michelle Folsom at PATH to send your message to Nancy Hathaway.

This evaluation has been explained to me, and all my questions have been answered. I agree to participate in the evaluation.

Name and signature _____

Date _____

Anonymous Questionnaire—Needlestick Injuries

Thank you for taking the time to complete this questionnaire. PATH and the KwaZulu Natal (KZN) Department of Health are interested in learning more about needlestick injuries in clinics, community health centers, and hospitals in KZN. It will take you no longer than 10 minutes to complete this questionnaire. This questionnaire is anonymous — we do not want you to write down your name or the name of your facility on this questionnaire. The information that you write down will be kept confidential. After you have completed the questionnaire, please return it to the locked collection box.

Your choice to complete this questionnaire is completely voluntary. Similarly, you may decide not to answer some of the questions. If you decide not to complete the questionnaire, or to complete only a portion of it, this will not effect your job in any way.

Date: _____

Please tick the relevant box

1. Facility type:

- Clinic (including mobile clinics)
- Community health center
- Hospital (including District and/or Regional)

2. Your role at facility (check all that apply):

- Injection provider (Health care worker giving the injections)
- General assistant/orderly
- Waste handler
- Supervisor
- Other: _____

3. Are retractable syringes used at your facility?

- Yes
- No
- Don't know

4. If YES, how long have you used retractable syringes for injections? _____

Needlestick injuries:

1. During the past 12 months, approximately how many needlestick injuries have you personally had? _____
2. During the past 12 months, have you had a needlestick injury while using a retractable syringe? If you are a waste handler, in the past 12 months, have you been pricked by a retractable syringe?
 - Yes
 - No
 - Don't know
3. What were the circumstances associated with your most recent needlestick injury? (Whether due to retractable syringe or another type of syringe)
 - Recapping a needle
 - Unexpected patient movement
 - During cleanup within the ward
 - Collision with coworker
 - During sharps disposal
 - Transferring/processing of specimens
 - During waste collection/transport
 - Other: _____
4. In which ward/setting were you working when the needlestick injury occurred?

5. Did you report the needlestick injury to anyone?
 - Yes (If YES, please answer questions 6–8)
 - No (If NO, please go to question 9)
6. If you personally had a needlestick injury, did you receive post-exposure prophylaxis (PEP)?
 - Yes
 - No
7. If you received PEP, from whom did you receive it?
 - From the facility where I work
 - From a private pharmacy
 - Other: _____
8. If you did not receive PEP, why not?
 - Concerned about possible side effects
 - PEP was not available at my facility

- I don't know what PEP is
- Other: _____

9. If you did not report the needlestick injury, why not?

- Didn't know I was supposed to report it
- Was not concerned about needlestick injury
- Too busy/didn't have time
- Didn't want to admit needlestick injury to supervisor
- Didn't want to take HIV test
- Didn't want to take PEP
- Other: _____

10. What might inhibit or prevent a person from reporting a needlestick injury in your health facility?

- Employee doesn't know she/he is supposed to report it
- Employee not concerned about needlestick injury
- Employee too busy/didn't have time
- Employee didn't want to admit needlestick injury to supervisor
- Employee didn't want to take HIV test
- Employee didn't want to take PEP
- Other: _____

11. What would encourage someone to report a needlestick injury and get PEP?

- Having a confidential place to report needlestick injury
- Supervisor encourages us to report needlestick injuries
- Having more information on risks of needlestick injury
- Having more information on the importance of reporting
- Having a confidential place to get PEP that is close by
- Having more information on how to prevent needlestick injuries
- Other: _____

12. What recommendations do you have to reduce the risk of needlestick injuries in the facility where you work?

Observation Checklist

To be completed by evaluation team. Each team member should observe at least 5 health workers per facility. One form per health worker observed.

Date: __ / __ / 2006

Facility Code: _____

Ward: _____

Retractable syringe use / injection safety:

What type of injection was given?

- a. Intramuscular b. Subcutaneous
 c. Intradermal d. Push IV

Did the injection provider use a retractable syringe? Yes No

If not, why not?

- a. Broken b. Couldn't find c. Ran out d. Didn't like using it
 e. Not appropriate for that procedure: _____

1. Did the HW retract the syringe properly, while the needle was still in the patient? Yes No
2. Did the HW inform the patient prior to the injection about the click and disappearance of the needle? Yes No
3. Did the patient have a reaction to the retractable syringe? Yes No
Describe: _____
4. Was the syringe used for procedures it should not have been used for? Yes No
Describe: _____
5. What did the injection provider do with retractable syringes after injection?
 Put in sharps container
 Put in infectious waste bag
 Put in reusable plastic sharps container
 Other _____
6. If sharps containers were not used, describe how used retractable syringes were contained:

Focus Group Discussion Guide

Use to facilitate discussion with injection providers.

Consent and introduction script

Thank you for taking the time to come to this focus group discussion where we will talk about the retractable syringe. I want to hear about your opinions of the device and your impressions of how it fits into your health facility's system. I am interested in the experience that each of you had. There are no right or wrong answers in this discussion.

This discussion will take no more than one and a half hours. We would like to tape record the session to help us capture the whole discussion. We will not write down or report your names. The evaluation investigator will keep any information you share today confidential. We ask each of you to respect each other's privacy and request that whatever other people talk about during this session remain in this room and not be discussed after the session is completed. We cannot promise however that respondents here today will keep the discussion confidential.

Your choice to take part in this discussion is completely voluntary. You may leave if you want to and it will not effect your job in any way. If anyone does not feel comfortable having the session taped, please say so at this time. If you have any questions, please feel free to ask them now or after the focus group has ended.

Retractable syringe use

1. Has each one of you used this retractable syringe? In what situations did you use it?
2. What types of injections did you give with the retractable syringe? Did it work with all types of injections?
3. In this clinic/ward/department, for what percentage of injections do you use retractables? How many retractables are used each day?
4. How well did the device work?
(Probe: Was it reliable? If not, what happened?)
5. How has the retractable syringe changed your job?
(Probe: Easier, faster, less dangerous, pride?)
6. What do you like about the retractable syringe?
(Probe: Ease of use, makes job easier or harder, eliminates sharps, prevents reuse, personal safety, community safety, cleanliness of facility, reduced volume of waste?)
7. What things do you not like about the retractable syringe?
(Probe: Malfunctioned, hard to use, not available when needed, didn't work for all injections, forget to retract needle, time requirements, felt unsafe?)
8. How has the retractable syringe changed your handling of needles and syringes?
9. How do patients react to your use of the retractable syringe?

10. In what settings is the retractable syringe most useful?

(Probe: Outreach, busy clinic, or hospital?)

Disposal

11. What do you do with the used syringes? Has the retractable syringe changed the way you dispose of syringes?

12. Is waste any safer when using the retractable syringe? Who, if anyone, gets safety advantages when retractable syringes are used? *(HWs? Patients? Community/children?)*

13. Have retractable syringes had any impact on other waste treatment or destruction aspects of sharps disposal? *(Probe: Eliminate need to disinfect with chemicals, eliminate need to incinerate as often, less waste?)*

Needlestick injuries

14. How common are needlestick injuries among clinic health workers?

15. How often do health workers receive needlestick injuries?

16. Has the frequency of needlestick injury changed since retractable syringes have been introduced? If so, what do you think has changed the frequency of needlesticks?

17. When do most needlestick injuries occur? During which procedure or activity?

18. Where do most needlestick injuries occur? In which ward or setting? Are needlesticks more common in certain settings?

19. What do you do if you get stuck by a needle?

20. Do most health workers report needlestick injuries?

21. What keeps health workers from reporting?

22. What would make it more comfortable for health workers to report needlestick injuries?

23. What are the best ways to avoid needlestick injury?

General recommendations and comments

24. Are retractable syringes worth paying a higher price for? How much more? 50% more than a disposable? Twice the price of a disposable?

25. If you've used autodisable syringes in immunization programs, how are retractable syringes different? *(Probe: better, safer, etc?)*

26. If you had a limited supply of retractable syringes in your health facility, how would you prioritize their use? In which wards or settings would you use them?

Interview Guide for Managers & Supervisors

Date: __/__/2006

Facility code: _____

Job title: _____

1. In your opinion, are needlestick injuries a source of concern for health care workers?
2. What is the procedure for accessing post-exposure medications in this facility? Are the medications always available? If not, why not?
3. In your opinion, how has the introduction of retractable syringes in your facility affected your safety or the safety of other health workers?
4. How has the introduction of retractable syringes in your facility affected health workers satisfaction with their jobs?
5. How about medical waste—what effect have retractable syringes had on medical waste systems?
6. How has the introduction of retractable syringes in your facility affected patient satisfaction?
7. In your opinion, what, if any, negative effects has the introduction of retractable syringes had in your facility?
8. How easy was it for health workers to learn to use retractable syringes?
9. In your opinion, how much training should be required to introduce retractable syringes in a new facility? What problems would you expect if no training occurred?
10. Where do you think retractable syringes should be used? In all facilities and wards, or in selected locations? Please explain.
11. If you had a limited supply of retractable syringes in your health facility, how would you prioritize their use? In which wards or settings would you use them? Why?
12. Retractable syringes are more expensive than disposable syringes. Do you think the government should pay the extra money to obtain retractable syringes? How much more do you think the government should pay for a retractable syringe than for a disposable syringe?
13. Has the introduction of retractables affected health worker willingness to treat HIV-positive patients?
14. What other comments do you have regarding the introduction of retractable syringes in your work place?

Interview Guide/Focus Group Discussion Guide for Waste Handlers

At facilities with a small staff, waste handlers will participate in in-depth interviews. At larger facilities, they will participate in focus group discussions.

Date: __/__/2006

Facility code: _____

Job title: _____

1. Please describe the flow of waste in this facility.
(Probe: What happens to a syringe immediately following the injection through to final disposal at treatment site.)
2. How is the retractable syringe disposed of in this facility? Are retractables treated differently than disposable syringes?
3. Is waste any safer when using the retractable syringe? Who, if anyone, gets safety advantages when retractable syringes are used?
(Probe: HWs? Patients? Community/children?)
4. In your opinion, how has the introduction of retractable syringes in your facility affected your safety or the safety of other health workers?
5. How has the retractable syringe changed your job?
(Probe: Easier, faster, less dangerous, pride?)
6. What do you like about the retractable syringe?
(Probe: Ease of use, makes job easier or harder, elimination of sharps, prevents reuse, personal safety, community safety, cleanliness of facility, reduced volume of waste?)
7. What things do you not like about the retractable syringe?
(Probe: Malfunctioned, hard to use, not available when needed, didn't work for all injections, time requirements, felt unsafe?)
8. How has the retractable syringe changed your handling of needles and syringes?
9. In what settings is the retractable syringe most useful?
(Probe: Outreach, busy clinic, or hospital?)

Needlestick injuries

10. How common are needlestick injuries among waste handlers?
11. Has the frequency of needlestick injury changed since retractable syringes have been introduced? If so, what do you think has changed the frequency of needlesticks?

12. When do most needlestick injuries occur? During which procedure or activity?
13. What do you do if you get stuck by a needle?
14. Do most waste handlers report needlestick injuries?
15. What prevents waste handlers from reporting needlestick injuries?
16. What would make it more comfortable for waste handlers to report needlestick injuries?
17. What are the best ways to avoid needlestick injury?

General recommendations and comments

18. Are retractable syringes worth paying a higher price for? How much more?
19. If you had a limited supply of retractable syringes in your health facility, how would you prioritize their use? In which wards or settings would you use them?
20. What other comments do you have about the introduction of retractable syringes in your workplace?
21. Within the waste disposal system, what changes or improvements would make your job safer/easier/better?

Interview Guide for Decision-Makers

Date: __/__/2006

Facility code: _____

Job title: _____

1. Why did the KZN Department of Health (DoH) decide to introduce retractable syringes into some of its health facilities?
2. What factors did the DoH take into account, before making the decision to order retractable syringes?
3. Was it a difficult decision to make, given that retractables are more expensive and the DoH has limited funds to work with? Did the DoH need to allocate fewer funds to another type of supply in order to purchase retractables?
4. Have you seen any benefits or advantages within the facilities to using retractable syringes?
5. Have health workers experienced any problems with the retractable syringe?
6. If you had a limited amount of money with which to purchase retractable syringes, in which areas/departments/wards would you prioritize their use?
7. If funds were not limited, in which facilities/wards would you use the retractable syringe?
8. How have health workers reacted to the introduction of retractable syringes?
9. Have retractable syringes had any effect on medical waste?
10. Are you happy with the decision to order retractable syringes? Will you continue to order them in the future? Why or why not?
11. Do you feel that the use of retractable syringes for intramuscular injections should be incorporated into Provincial policy? National policy? Why or why not?

Appendix B—Post-Exposure Prophylaxis Policy for South Africa*

SECTION 5: POST-EXPOSURE PROPHYLAXIS (PEP)

Prophylaxis after occupational exposure to HIV

Introduction

Health care workers have a low but measurable risk of HIV infection after accidental exposure to infected blood or body fluid.

Compliance with infection control recommendations in handling sharps is the mainstay in the prevention of occupational HIV infection. Additional prevention strategies now include post-exposure prophylaxis with ART.

Risk of infection

Factors that increase the risk of sero-conversion include:

- Exposure to large inoculum of infected blood indicated by:
 - a deep injury
 - visible blood on device
 - procedures involving needles
- Source patient with terminal HIV infection

When to commence treatment

Treatment has to commence as soon as possible within 1 to 2 hours of exposure – **the sooner the better.**

The HIV status of the injured person needs to be known as initiating HIV prophylaxis in an infected person could endanger their future treatment options. This is because dual therapy could lead to resistance.

In situations where there is a high suspicion that the patient may be in the window period, consider HIV PCR testing. Starter pack prophylaxis should also be provided.

For further information, consult the national guidelines on "Management of Occupational Exposure to HIV".

Table 24: Recommendations for post-exposure prophylaxis (PEP) after occupational exposure

This includes blood, CSF, semen, vaginal secretions and synovial/pleural/pericardial/peritoneal/amniotic fluid from HIV sero-positive patients.

| Exposure | HIV status of source patient | | |
|--|------------------------------|--------------------------|--------------------------|
| | Unknown | Positive | High risk* |
| Intact skin | No PEP | No PEP | No PEP |
| Mucosal splash/ non-intact skin | Consider 2-drug regimen | Recommend 2-drug regimen | Recommend 2-drug regimen |
| Percutaneous (sharps) | Recommend 2-drug regimen | Recommend 2-drug regimen | Recommend 3-drug regimen |
| Percutaneous (needle in vessel or deep injury) | Recommend 2-drug regimen | Recommend 3-drug regimen | Recommend 3-drug regimen |

* See text for definition of high risk exposures

Table 25: Recommended PEP drug regimen

| Drug | Dose | Frequency | Duration |
|--|------------------|-----------|----------|
| Zidovudine (AZT) Lamivudine (3TC) | 300 mg 150 mg | 12 hourly | 28 days |
| Lopinavir/tritonavir in cases of high exposure | 400 mg/100 mg | 12 hourly | 28 days |

Monitoring after occupational exposure

- Prophylaxis must be given for 28 days.
- Following HIV exposure, there is a need for psycho-social support.
- Laboratory monitoring is done to exclude acquisition of HIV infection and, for those given PEP, to monitor toxicity.
- Health care workers should be tested for HIV infection at the time of the exposure, and again at 6 weeks, 3 months and 6 months.

* South Africa Department of Health. National Antiretroviral Treatment Guidelines. First Edition, 2004.
Available at: <http://www.doh.gov.za/docs/policy-f.html>

Appendix C—Cost Assumptions and Definitions

The model assumes that with the introduction of retractable syringes, there will be no need for:

1. An increase in building space at any level of the system.
2. An increase or decrease in storage space at any level of the cold chain system.
3. An increase or decrease in transport costs at any level of the logistics system.
4. An increase or decrease in administrative personnel at any level of the health system.

Training and microplanning costs: Retractable syringe training costs are covered by the local supplier. Given the scarcity of information on microplanning and training costs, we assumed a cost of 0.10 Rand for training.

Personnel costs: The cost of health worker's time consists of the health worker's salary, including benefits (cost per minute) multiplied by time in seconds to give an injection. The use of retractable syringes saves time compared to when using disposable syringes, based on observations from health clinics.

Supplies: The cost of disposable syringes is the cost of disposable syringes and needles procured by the KwaZulu Natal (KZN) Department of Health (DOH) (hospitals handle procurement). The cost of retractable syringes is the cost of retractable syringes procured by the KZN DOH (hospitals handle procurement). Since there is no difference in the wastage factors between the two syringes, the wastage factor is not included in the incremental analysis, as it would net out.

Waste disposal costs: With retractable syringes, fewer sharps containers are needed, and therefore, disposal costs are less when retractable syringes are used. A 5-L sharps container can hold 151 retractable syringes or 100 disposable syringes. The costs are estimated based on these differences in volume. Waste disposal costs include the cost of a 5-L sharps bin and the collection cost from a waste disposal service.

Treatment costs for PEP and HIV, hepatitis B, and hepatitis C infections:

The recommended post-exposure prophylactic (PEP) drug regimen consists of zidovudine (AZT), Lamivudine (3TC) and Lopinavir/ritonavir for 28 days. Treatment costs for HIV infection include a daily regimen of stavudine, lamivudine, and nevirapine, in addition to regular testing for CD4, viral loads, and LFTs. A recent Danish study found that life expectancy after infection is 39 years, if properly treated.³⁴ We assume that the average age of the health worker is 28 years old and that the annual drug and laboratory costs were for 9 years and discounted at 3% per year. There is no hepatitis B treatment for acute infection; only 5%–10% of acutely infected adults become chronically infected and not all require treatment. Similarly, there is no treatment for acute hepatitis C infection. Approximately 80% of adults acutely infected with hepatitis C become chronically infected and require treatment. The full course treatment for chronic hepatitis B is intron A over 16 weeks. The full course treatment for chronic hepatitis C is intron A for 24 weeks. Table C2 provides the detailed unit and total costs for PEP medication and laboratory tests, as well as the costs for treatment of HIV, hepatitis B, and hepatitis C.

Table C1: Prices of injection supplies, waste disposal costs and medical costs for the management of needle stick injuries among health care workers

| | Unit cost (rand) |
|--|-----------------------------|
| Injection supplies | |
| Retractable 5-ml 22G 1" needle | 3.15 |
| Disposable syringe 5 ml | 0.25 |
| Disposable needle | 0.1 |
| Sharps Bin 5-L - Container Cost | 8.8 |
| Sharps Bin 5-L - Collection Cost | 8.39 |
| Disposal cost per single disposable syringe | 0.17 |
| Disposal cost per single retractable syringe | 0.11 |
| Medical costs for managing needlestick injuries | |
| Post-exposure prophylaxis medication | |
| Full course for HIV | 450.9 |
| Starter pack for HIV for 3 days | 22.52 |
| Laboratory tests | |
| Source HIV-negative (health care worker taken off PEP) | 2151.9 |
| Source HIV-positive (health care worker receives full course of PEP) | 4472.8 |
| Treatment costs | |
| Total annual cost for HIV infection | 3557.08 |
| Full course treatment for chronic Hepatitis B | 9,229.00 |
| Full course treatment for chronic Hepatitis C | 13,824.00 |

Table C2: Cost of post-exposure prophylaxis: medication and laboratory tests

| Medication^a | Cost (Rand) |
|---|--------------------|
| HIV | |
| AZT (28 days) | 85.15 |
| 3TC (28 days) | 37.15 |
| Kalitra-Lopinavar (28 days) | 328.60 |
| Total cost of medication for HIV | 450.90 |
| Starter pack 3 days of AZT, 3TC, Kalitra | 22.52 |
| Hepatitis B ^b | |
| Hepatitis B vaccine, per dose | 16.52 |
| Hepatitis B IgG (immunoglobulin) | 369.10 |
| Laboratory tests^c | Cost (Rand) |
| Source Patient—Test occurs ASAP after needlestick injury | |
| HIV rapid | 7.2 |
| HIV ELISA | 111.90 |
| HBV | 115.00 |
| HCV | 115.00 |
| Syphilis | 243.00 |
| P24 (if source negative by ELISA) | 98.60 |
| Health Care Worker—Test occurs ASAP after needle stick injury | |
| HIV ELISA | 111.90 |
| HIV PCR (if ELISA neg) | 595.30 |
| HBV immunity | 115.00 |
| Urea and Electrolyte (U&E) | 154.40 |
| LFT | 342.20 |
| Amylase | 41.20 |
| FBC | 101.20 |
| Testing after 2 weeks: | |
| Urea and Electrolyte (U&E) | 154.40 |
| LFT | 342.20 |
| Amylase | 41.20 |
| FBC | 101.20 |
| Testing after 4 weeks: | |
| Urea and Electrolyte (U&E) | 154.40 |
| LFT | 342.20 |
| Amylase | 41.20 |
| FBC | 101.20 |
| HIV ELISA at 6 Weeks | 111.90 |
| HIV ELISA at 3 Months | 111.90 |
| HIV ELISA at 6 Months | 111.90 |
| HIV ELISA at 1 Year | 111.90 |
| PCR if ELISA is negative | 595.30 |
| Total Cost of Lab Testing if Source HIV-negative | 2,151.90 |
| Total Cost of Lab Testing if Source HIV-positive | 4,472.80 |

| Costs for treatment of HIV infection^d | Cost (Rand) |
|---|--------------------|
| Drug | |
| Stavudine 40 mg-60s | 22.46 |
| Lamivudine 150 mg-60s | 44.69 |
| Nevirapine 200 mg-60s | 43.14 |
| Total Monthly Cost of Regimen | 110.29 |
| Total Annual Cost of Regimen | 1,323.48 |
| Laboratory monitoring tests during treatment^e | Cost (Rand) |
| Test | |
| CD4 | 155.1 |
| Viral Load | 619.5 |
| LFTs | 342.2 |
| Total biannual cost | 1,116.8 |
| Total annual cost | 2,233.6 |
| Total Annual Costs for Treating HIV | 3,557.08 |
| Full Course Treatment Chronic Hep B^{f,g} | 9,229.00 |
| Intron A; 3 miu, 3/week x 16 weeks | |
| Cost (Full Course) Treatment Chronic Hep C^f | 13,824 |
| Intron A; 3miu, 3/week x 24 weeks | |

Notes:

- a. Source of testing protocol from Port Shepstone Hospital and the source of test pricing is Lancet Labs, SA; Similar prices obtained from KZN DOH Pharmaceutical Services.
- b. Hepatitis B is very rare, and there is no PEP for Hepatitis C.
- c. Source of pricing is Lancet Labs, SA.
- d. Source of cost of treatment is KZN DoH Pharmaceutical Services.
- e. Source of pricing is Lancet labs, SA.
- f. Source of costs is Mays Chemist Johannesburg, SA.

Appendix C3: Model variables, data, and assumptions

| Variable | Data and assumptions | Year | Source |
|--|----------------------|------------|--|
| Demographic indicators | | | |
| South Africa Population | 47.4 million | 2006 | www.statssa.gov.za |
| KZN Population | 9.9 million | 2006 | |
| Total number of health workers | | | |
| Public and Private Sectors | | | SA Health Review |
| Professional nurses/midwives | 98,490 | 2004 | |
| Enrolled nurses/midwives | 35,266 | 2004 | |
| Enrolled nursing auxiliaries | 50,703 | 2004 | |
| Public Sector Only | | | |
| Professional nurses/midwives | 43,660 | 2005 | |
| Enrolled nurses/midwives | 20,582 | 2005 | |
| Enrolled nursing auxiliaries | 31,006 | 2005 | |
| Injection reuse and injuries | | | |
| Number of injections per person | 2.0 | 2005 | WHO regional estimates |
| Assumed proportion of needle reuse | 2% | 2006 | Assumption based on expert opinion |
| Mean number of sharps injuries/health care worker/year | 2.1 | 2003 | Prüss-Ustün, et al. |
| Percent of sharp injuries that are preventable | 32% | 2004 | Wilburn & Eijkemans |
| Percent of sharp injuries that are reported | 60% | 1999; 1997 | Osborn, CDC |
| HIV, hepatitis B and hepatitis C infections | | | |
| Prevalence rates | | | |
| HIV | 18.8% | 2003 | South Africa HIV/AIDS Estimates |
| HBV | 10-15% | 2006 | Head virologist at the University of KZN |
| HCV | 5-7% | | |
| Rate of transmission | | | |
| HIV | 0.3% | 1995 | Aylward et al. |
| HBV | 30% | | |
| HCV | 3% | | |
| Percent of health workers vaccinated with Hepatitis B* | | | |
| 2 doses | 60% | 2006 | Focus group discussion |
| 3 doses | 30% | | |
| Effectiveness of PEP | | | |
| HIV | 81% | 2003; 1997 | Prüss-Üstün et al; Cardo et al. |
| Hepatitis B | 85-95% | | |

Appendix D—Results of Economic Analysis: Tables

| | |
|--|-----|
| Table D1: Average unit and total incremental costs associated with retractable syringes ... | D-2 |
| Table D2: Medical costs for immunization-related needlestick injuries as reported by health workers (Rand)..... | D-3 |
| Table D3: Sensitivity analysis for different prices of the retractable syringe for a hospital setting..... | D-4 |
| Table D4: Estimated proportion of unsafe injections (reuse and needlestick injuries) and estimated number of hepatitis B, hepatitis C, and HIV infections for South Africa and KwaZulu Natal | D-5 |
| Table D5: Infections in health care workers attributable to needlestick injuries in South Africa and KwaZulu Natal..... | D-5 |
| Table D6: Health outcomes, costs and cost-effectiveness ratios for retractable syringes | D-6 |
| Table D7: Sensitivity analysis for the percent of infections receiving treatment, cost per safe injection, cost per case averted, and cost per DALY averted | D-7 |

Table D1: Average unit and total incremental costs associated with retractable syringes

| | Unit costs | | Hospital setting | | | Clinic setting | | |
|---|-------------|--------------|----------------------------|---------------------|-------------------|----------------|------------------------------|----------------|
| | | | Total costs | | Total costs | | Average number of injections | |
| | Rand (2006) | US \$ (2006) | Total number of injections | Rand (2006) | US \$ (2006) | Rand (2006) | | US \$ (2006) |
| Medical costs incurred | | | | | | | | |
| Start-up costs | | | | | | | | |
| Start-up microplanning and training (+) | 0.10 | 0.01 | 441,984 | 44,198.40 | 6,305.05 | 3,918 | 391.80 | 55.90 |
| Subtotal | 0.10 | 0.01 | 441,984 | 44,198.40 | 6,305.05 | 3,918 | 391.80 | 55.90 |
| Recurrent costs | | | | | | | | |
| Retractable syringes (+) | 2.80 | 0.40 | 441,984 | 1,237,555.20 | 176,541.40 | 3,918 | 10,970.40 | 1,565.00 |
| Waste disposal (-) | (0.29) | (0.04) | 441,984 | (126,292.98) | (18,016.12) | 3,918 | (1,119.53) | (159.71) |
| Personnel (-) | (0.02) | (0.00) | 441,984 | (6,774.15) | (966.36) | 3,918 | (60.05) | (8.57) |
| Subtotal | 2.50 | 0.36 | 441,984 | 1,104,488.07 | 157,558.93 | 3,918 | 9,790.82 | 1,396.70 |
| Total incremental cost per retractable syringe | 2.60 | 0.37 | | 1,148,686 | 163,863.98 | | 10,183 | 1,452.6 |

Table D2: Medical costs for injection-related needlestick injuries as reported by health workers (Rand)

| | Average cost per reported needlestick | Hospital setting total costs (N=81) | Clinic setting total costs (N < 1.16) |
|---|---------------------------------------|-------------------------------------|---------------------------------------|
| Medical costs saved | | | |
| Costs for managing needlestick injury for HIV, hepatitis B, and hepatitis C | 2,601 | 210,153 | 3,006 |
| Average lifetime HIV treatment costs | 9 | 435 | 10 |
| Average lifetime hepatitis B treatment costs | 1 | 95 | 1 |
| Average lifetime hepatitis C treatment costs | 1 | 80 | 1 |
| Subtotal | 2,612 | 210,763 | 3,019 |
| Total net cost per retractable syringe | | 937,923 | 7,164 |
| Average net cost per additional injection given | | 2.12 | 1.83 |

N = the number of reported needlestick injuries.

Table D3: Sensitivity analysis for different prices of the retractable syringe for a hospital setting

| Change in variable | Total incremental cost per syringe (Rand) | Net incremental cost per syringe (Rand) | US \$ |
|---|---|---|----------|
| Number of needlestick injuries | | | |
| Baseline: 135/81 reported | 2.60 | 2.12 | \$0.30 |
| Increase to 741/445 reported | 2.60 | -0.025 | \$0.00 |
| Scenario 1: Baseline with 60% of all needlesticks reported | | | |
| Baseline SA price (3.15) | 2.60 | 2.12 | \$0.30 |
| Reduce baseline SA price by: | | | |
| 10% (2.84) | 2.28 | 1.81 | \$0.26 |
| 20% (2.52) | 1.97 | 1.49 | \$0.21 |
| 30% (2.21) | 1.65 | 1.18 | \$0.17 |
| 40% (1.89) | 1.34 | 0.86 | \$0.12 |
| 50% (1.58) | 1.02 | 0.55 | \$0.08 |
| PEPFAR price (US \$ 0.15; 1.05 Rand) | 0.50 | 0.02 | \$0.003 |
| Break-even price (1.02) | 0.47 | 0 | 0 |
| Scenario 2: 80% of all needle sticks reported | | | |
| Baseline SA price (3.15) | 2.60 | 1.69 | \$0.28 |
| Reduce baseline SA price by: | | | |
| 10% (2.84) | 2.28 | 1.65 | \$0.23 |
| 20% (2.52) | 1.97 | 1.33 | \$0.19 |
| 30% (2.21) | 1.65 | 1.02 | \$0.14 |
| 40% (1.89) | 1.34 | 0.7 | \$0.10 |
| 50% (1.58) | 1.02 | 0.39 | \$0.06 |
| PEPFAR price (US \$ 0.15; 1.05 Rand) | 0.50 | (\$0.14) | (\$0.02) |
| Break-even price (1.20) | 0.64 | 0 | 0 |

* Estimates in parenthesis indicate cost savings.

Table D4: Estimated proportion of unsafe injections and estimated number of hepatitis B, hepatitis C, and HIV infections for South Africa and KwaZulu Natal * (as calculated by model)

| Assumed proportion of unsafe injections | South Africa | | | KwaZulu Natal | | |
|---|--------------|-------|-------|---------------|-----|-----|
| | HBV | HCV | HIV | HBV | HCV | HIV |
| 2% | 17,316 | 666 | 444 | 3,594 | 138 | 91 |
| 5% | 43,289 | 1,666 | 1,099 | 8,985 | 346 | 228 |
| 7.5% | 64,934 | 2,499 | 1,649 | 13,477 | 519 | 342 |

*Assumes that average number of injections received per person per year =2.

Table D5 : Infections in health care workers attributable to needlestick injuries in South Africa and KwaZulu Natal (as calculated by model)

| Category of health care worker | South Africa | | | KwaZulu Natal | | |
|--|--------------|-----|-----|---------------|-----|-----|
| | HBV | HCV | HIV | HBV | HCV | HIV |
| Public- and private-sector enrolled nurses | 13 | 8 | 1 | 4 | 2 | < 1 |
| Public-sector enrolled nurses | 7 | 4 | 1 | 3 | 2 | < 1 |

Table D6: Health outcomes, costs, and cost-effectiveness ratios for retractable syringes

| | South Africa | KZN |
|---|--------------|-------------|
| Health outcomes | | |
| Total number of infections avoided | | |
| Hep B | 17,316 | 3,594 |
| Hep C | 666 | 138 |
| HIV | 440 | 91 |
| Total number of DALYS avoided | | |
| Hep B | 1,191,235 | 1,208,652 |
| Hep C | NA | NA |
| HIV | 8,543 | 1,766 |
| Costs* | | |
| Cost of injection supplies** | 237,212,100 | 49,232,700 |
| Total medical costs averted | 243,473,104 | 58,407,059 |
| Net costs | (6,261,004) | (9,174,359) |
| Cost per safe injection | (0.04) | (0.26) |
| Incremental cost-effectiveness ratios (ICER) | | |
| Cost per case averted | | |
| Hep B | (362) | (2,553) |
| Hep C | (9,397) | (66,345) |
| HIV | (14,242) | (100,554) |
| Cost per DALY averted | | |
| Hep B | (5) | (5) |
| Hep C | NA | NA |
| HIV | (733) | (5,195) |

* Numbers in parenthesis are cost saving.

** Includes a mix of syringes for disposable and safety syringes.

Table D7 : Sensitivity analysis for the percent of infections receiving treatment: cost per safe injection, cost per case averted, and cost per DALY averted

| | South Africa | KZN |
|---|--------------|---------|
| Health Outcomes | | |
| Assumes only 75% of infections receive treatment | | |
| ICER | | |
| Cost per case averted (Rand) | 0.21 | (0.01) |
| Hep B | 2,101 | (90) |
| Hep C | 54,609 | (2,339) |
| HIV | 82,766 | (3,545) |
| Cost per DALY averted | | |
| Hep B | 31 | 30 |
| Hep C | NA | NA |
| HIV | 4,259 | (183) |
| Assumes only 50% of infections receive treatment | | |
| Cost per safe injection (Rand) | 0.47 | 0.24 |
| ICER | | |
| Cost per case averted | | |
| Hep B | 4,564 | 2,373 |
| Hep C | 118,615 | 61,667 |
| HIV | 179,775 | 93,464 |
| Cost per DALY averted | | |
| Hep B | 66 | 65 |
| Hep C | NA | NA |
| HIV | 9,251 | 4,828 |

1. Numbers in parenthesis are cost saving.
2. Includes a mix of syringes for disposable and safety syringes.

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