Effectiveness of quality improvement on occurrence of needle stick injuries (NSIs) in Harare city, Zimbabwe, 2017: A Quasi-experimental study

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Abstract

Background: Globally, healthcare workers (HCWs) incur an estimated two million needle stick injuries (NSIs) per year and 90% of these injuries occur in Africa. In Zimbabwe, neither the prevalence nor the factors associated with HCW-acquired NSI are known. Harare city recorded an increase in NSIs among nurses from 1% in 2013 to 7% in 2016, highest being from the Southern District. We designed and evaluated the effectiveness of a quality improvement (QI) approach towards reduction of NSI incidence. **Methods:** We conducted a quasi-experimental study purposively among 83 nurses in southern District. We designed and implemented an intervention package comprising training, deployment of social behavioral change materials and workflow re-organisation. We measured effectiveness of the intervention using Plan, Do Check Act cycle. Data on intervention effectiveness was collected pre and six months post-implementation, using structured questionnaires. Analysis was presented with frequencies, means, and proportions. **Results:** Lack of knowledge 99% (82/83), unorganised activities 60% (50/83) and limited space in the treatment rooms 59% (49/83), were the major reasons for NSI before intervention. Pre-intervention, 10% (8/83) of the nurses had good knowledge level while 96% (80/83) had good knowledge level post- intervention. The NSI incidence rates pre-intervention was 0.97 NSI/month and 0.17 NSI/month post-intervention, a decline rate of 82% ($p< 0.01$). Total cost saved by the intervention was $5 777.00. **Conclusions:** Lack of knowledge on occurrence of NSI, unorganised activities, and limited working space in the treatment rooms were the major reasons for NSIs before the intervention. The QI intervention was effective in reducing incidence of NSI. We recommend HCW trainings on NSI, promotion of socio-behavioral change and workflow re-organisation in order to offset economic efforts directed at managing NSIs.

Key words: Needle sticks injuries, quality-improvement, health care workers, Zimbabwe

Introduction

Needlestick injuries (NSI) are a serious concern for all health care workers (HCWs) and pose a significant risk of occupational transmission of bloodborne pathogens [1]. Globally, HCW incur two million needlestick injuries (NSIs) annually, 90% of which are in Africa [2]. These injuries account for about one-third of all occupational accidents encountered by HCWs in a healthcare setting [3]. Percutaneous injuries caused by needle sticks pose a significant risk of occupational transmission of bloodborne pathogens. Hepatitis B (HBV), Hepatitis C (HCV) and HIV are some of the biological hazards threatening the health of thousands of healthcare workers. The World Health Organization (WHO), has estimated that exposure to sharps in the workplace accounts for 40% of infections with Hepatitis B virus and Hepatitis C virus, and 2-3% of HIV infections among health care workers [4].

The health system incurs a variety of costs as an aftermath of NSI. These include direct costs for laboratory tests, cost of post-exposure prophylaxis for HCW, treatment cost of any resultant conditions, and economic loss due to absenteeism from work [5].Some indirect costs include depression, post-traumatic stress disorder and adjustment disorder. Sustaining NSI might affect the provision of health care services [6].

In developing countries, 40–60% of HBV infection among health care workers (HCWs) was attributed to professional hazard while in developed countries the attributable fraction was <10% due to vaccination coverage [7]. Poor compliances to universal precautions is a risk factor for sharp injuries and it doubles the risk to get an injury. In less developed countries, the risk of occupational transmission due to bloodborne exposures is increased due to recapping of needles, lack of resources, demotivated staff, work overload and inappropriate disposal of hazardous waste [8]. Research showed 40 – 75% under-reporting of these injuries more so in developing nations [9]. In Zimbabwe, neither the prevalence of NSI among HCWs is known, nor the factors associated with NSIs well understood [10].

A preliminary review of the Harare city NSI data showed a rise in NSIs among HCWs from 1% in 2013 to 7% in 2016, with Southern District recording highest proportion of NSIs (35/75) compared to

other districts in the city. The pursuit of high quality of care for health workers provides a rational system for cost containment [11]. The foundation of all quality and safety management systems is the quality improvement approach [12]. To reduce the NSI incidence, we determined the reasons for the increase in NSIs, designed and evaluated the effectiveness of quality improvement (QI) approach.

Methods

Study setting

We conducted the study in the Southern District, one of the four districts in Harare, the capital city of Zimbabwe. In comparison with other districts in the city, from 2013 to 2016, Southern District recorded the highest (47%) proportion of NSIs. The study was conducted in all the seven health facilities (six primary health care clinics and one infectious diseases hospital) in the district. All the six primary health care clinics offer similar services. In Zimbabwe, the primary health care clinics are the main vehicles through which health care programmes are implemented in Harare city. The services offered include: maternal and child health services; health education; nutrition education; expanded programme in immunisation; communicable diseases control; essential drugs programme; and the provision of basic and essential preventive and curative care.

Study Population

All Southern District nurses involved in the administration of vaccines and found on duty during the period of study were interviewed and trained. We reviewed the electronic staff clinic records of 2013 to 2016 so as to establish the magnitude of the problem and design the relevant intervention.

Study design

We conducted a quasi-experimental study among nurses working in health facilities in Harare city, Southern District. The study design incorporated a mixed method; exploratory design in the diagnosis phase, an intervention phase, and a quantitative evaluation phase, resulting in a before and after evaluation design. The methods used in the baseline phase comprised individual questionnaire-based interview, conduct of root-cause analysis and review of staff clinic records. These provided the information for the design of intervention package.

Sampling technique

Health facilities: We purposively selected Harare city Southern District due to its highest proportion of NSIs among other districts in the city. We considered all the six primary health care clinics and the one hospital in Harare city Southern District.

Health care workers: We recruited all 83 nurses from all departments at risk of NSIs, and that were on duty at the time of commencement of the study (Figure 1).

Data Collection

Phase 1

***Baseline phase*:** We trained data collectors, administered pre-tested structured questionnaires to health workers enrolled in the study to collect information on reasons for the increase of NSI in Harare city southern District. We undertook a root-cause analysis to identify reasons for an increase in NSI incidence in Southern District. We reviewed the staff clinic records on HIV post-exposure prophylaxis used and the number of NSI occurrences. Based on the outcome of the baseline assessment, we designed a quality improvement approach which comprised three interventions, namely – training, distribution of socio-behavioural change (SBC) materials and re-organisation of work environment and activities.

Training

We trained HCWs on the importance and availability of protection devices, biological hazards for HCWs, and prevention of the most frequent behavioural errors related to needle stick injuries, determining the NSI causes, how to prevent and manage NSIs as well as the proper reporting procedure in the event of an NSI. We were guided by the health safety and infection control guidelines of Harare city. All nurses in the district were trained. They were put in two groups of 41 and 42 nurses. We conducted full day training for each group. The two groups received the similar trainings. We took two days to train all nurses who were on duty. The HIV program manager, nurse managers, Health and safety personnel, infection control sister and an occupational health doctor were part of the trainers.

Distribution of socio-behavioural change (SBC) materials

We distributed posters to health facilities and SBC materials on NSI reporting procedures, prevention, and management to the seven health facilities in Harare city Southern District. We used the SBC materials designed by the ministry of health which are written in English. Each health facility received these SBC materials. Some were displayed on the walls while some were put in the pigeon holes on the tables for easy access to read. The posters were displayed on the walls of the procedure rooms and duty rooms, near the nurses' station.

Re-organization of work environment and activities

Based on the findings of the root-cause analysis undertaken to identify reasons for an increase in NSI incidence in Southern District at baseline phase, we used a checklist to assess the facilities' environment and activities. The facilities were assessed for the presence of NSI risks like presence of a sharps tin in each and every procedure room, storage of full sharps tin at the facility and order of activities of a procedure in the procedure room. HCWs were advised to re-organise the environment

as per need. The assessment was cconducted by the research assistants and the principal investigator. The assessment was done at baseline phase and after every 2 months for 6 months.

Phase 2

Intervention phase: The QI approach was implemented over a period of 6 months.

Phase 3

Post-intervention phase*:* Immediately after the intervention, we used the same study instruments that were deployed during the baseline assessment to interview the same study population at the beginning of the study.

Measurement of the effectiveness of the interventions

We used the Plan-Do-Check-Act (PDCA) Cycle as a monitoring and evaluation tool [13]. We implemented the elements of the PDCA cycles after every two months. We made comparisons between the pre-intervention and post-intervention phases. We evaluated the effectiveness of the QI interventions based on indicators, namely; HIV post-exposure prophylaxis usage, frequency, management cost of NSI, and changes in the level of knowledge of nurses about NSI. We determined HIV post-exposure prophylaxis usage through checking in the NSI records if the victim received HIV post-exposure prophylaxis or not.

Assessment of Knowledge level

We assessed the health workers awareness and understanding of the needle stick injuries pre and post-intervention. The variables looked at were: ability to accurately state the biological hazards for HCW, causes of NSI, prevention of the most frequent behavioural errors related to NSI and stating the correct reporting procedure for NSI. The proportions of respondents who gave accurate responses to each of

the variables were recorded. A 5 Point Likert scale was used to measure knowledge level. Those who answered two or less (<2) questions correctly out of five had low knowledge level, three out of five had fair knowledge level while those who answered four and above (>4) were classified as having high knowledge level.

Based on the average salary of $1200. 00 per month per HCW, the price of $50 for PEP and $50.00 for laboratory tests (tests for HIV antibodies, Hepatitis B serology and Hepatitis C baseline tests), we computed the expected direct cost management of NSI in the absence of QI interventions.

Data analysis

We analysed data using Epi Info Version 7 ™ statistical analysis package to capture and analyse the data. Data were cleaned by checking for missing variables like age, sex etc. and checking for inconsistent responses. The questionnaires were used to correct any mistakes in the consistency of data entry. The software was used to perform univariate analysis that is to calculate frequencies, means and proportions. Results were presented using descriptive statistics. At 5% level of significance, we used the *Z* score test for two population proportions to ascertain the difference in the occurrence of NSIs.

Ethical considerations

We obtained permission to carry out the study from the Harare city institutional review board and the Health Studies Office. We obtained written informed consent from all the interviewees before enrollment into the study. Confidentiality was assured and maintained throughout the study by keeping questionnaires under lock and key and ensuring data security, with access granted only to the principal investigator.

Results

Demographic characteristics of health care workers

Overall, 83 HCW were enrolled, 74 (89%) of whom were females. The median years in service of the participants were 11 (interquartile range: 6 - 15). All 83 HCWs were interviewed before and after the assigned intervention. All received training on NSI and were followed up 6 months post-intervention.

Reasons for the increase in the occurrence of needle stick injuries among health care workers

About 99% (82/83) cited lack of knowledge as the reason for the increase in the occurrence of NSI, while unorganised activities were cited by 60% (50/83) of the participants. A total of 59% (49/83) reported having limited space in the treatment rooms as another contributing reason for NSI occurrence (Table 1).

The incidence of NSI among health care workers before and after intervention

Prior to the intervention, a total of 35 NSI over 36 months (December 2013- December 2016) were recorded from different health workers in the district. No health worker had a repeat NSI. This shows that at baseline (6 months prior QI approach), monthly NSI incidence rate was 0.97/ month. Due to use of a condemned sharps disposal tin, a single NSI occurred over the 6 months post-intervention showing an NSI incidence rate of 0.17 NSI/month. The NSI incidence rates decreased significantly from 0.97/ month to 0.17/month ($p< 0.01$), representing 82% overall decline in NSI incidence rate (Figure 2).

Rate of Needle Stick Injuries Pre and Post Intervention Stratified by health facility

Stratifying by health facility, there was a reduction in rate of NSIs occurrences in all health facilities. Changes at three facilities were statistically significant (BRIDH- p value-0, Mbare Poly, p value -0.001 and Waterfalls, p value- 0.04). Figure 3.

The total cost saved by the intervention over a 6-month period in Harare city

Based on the total estimated cost of $1300.00 for a single NSI and using an average rate of a single NSI per month, the total cost for managing NSI 6-months before the intervention was (6×$1300.00=$7800.00). The cost of managing a single needle stick injury six months after the intervention was (1×$1300.00=$1300.00). The total cost of training 83 HCW was $523.00. Training a single HCW cost $6.30. The total cost spent on designing posters and SBC materials was $200. The total cost saved by the intervention over a 6-month period was ($7800.00) - ($1300.00+$523.00+$200.00) = $5777.00 (Table 2).

Knowledge of health care workers on needle sticks injury

NSI knowledge levels were higher post-intervention as compared to pre-intervention phase. Before intervention 10% (8/83) of the nurses had good knowledge level, 36% (30/83) had fair knowledge level, and 54% (45/83) had poor knowledge levels. After intervention 96% (80/83) had good knowledge level, 3% (2/83) had fair knowledge, and 1 % (1/83) had poor knowledge levels (Table 3).

Use of Hepatitis vaccination and HIV post-exposure prophylaxis

None of the victims of the 35 NSI before the intervention had been vaccinated against Hepatitis B. The HIV post-exposure prophylaxis doses used before intervention were 50. The number of NSI recorded before intervention was 35. A single dose of HIV post-exposure prophylaxis was used after intervention. A single NSI was recorded 6 months post-intervention.

Discussion

In this study, the primary reported reasons for the increase in NSI incidence before intervention were lack of NSI knowledge, unorganised activities, and limited working space in the treatment rooms. We found low awareness of HCWs about preventive behaviours and NSI management. Introduction of the QI approach resulted in a marked reduction in the incidence of NSIs occurrence, improved HCWs' knowledge on NSI and it averted a possible organisation's economic loss.

Findings of this study imply that the structured QI approach in the prevention of NSIs had an impact on the occurrence of NSIs. The reduction could be attributed to the existence of the QI approach deployed in this study. This finding is similar to a systematic review and meta-analysis by Ballout *et al.*, which reported a 50% to 60% reduction in the incidence of NSI associated with the use of phlebotomy devices [14]. This figure (50%-60%) is less than what we found (82%) in our study. The NSI reduction rate (82%) is higher in our study because we deployed multi-faceted interventions as compared to a single intervention used in Ballout's study. The 82% decline rate of incidence of NSI further corroborates the effectiveness of these interventions.

Before intervention, lack of knowledge was cited as the main reason for increased NSI incidences. This is similar to findings of Kebede *et al.* on the prevalence of NSI and the associated factors among nurses working in public hospitals of Dessie town, Northeast Ethiopia 15], which showed a low level of awareness risk practices for NSI among HCWs. However, our study demonstrated that knowledge of HCWs on NSI improved after the training. In less developed countries, the risk of occupational transmission due to bloodborne exposures is increased mainly due to lack of knowledge on NSI occurrence, lack of resources, demotivated staff, work overload and inappropriate disposal of hazardous waste [16]. Our study findings are also consistent with Huang *et al.*, 2018, who found out that NSI training has the potential to positively impact workers' knowledge of the risks posed by needles [17].

In this study, we also found that the cost of managing NSIs was more than the cost of mounting an intervention. Also the intervention was cost effective as it saved about $5777.00 within 6 months. Previous studies reported similar findings. An economic evaluation of training in reducing NSI incidences among health care workers in South Africa showed that the intervention was cost-effective [18]. Additional costs incurred though not assessed in this study; include the intangible costs such as posttraumatic stress disorders associated with NSI. These intangible costs may equal the costs of medical evaluation, and if a HCW is to acquire HIV through NSI, they will require lifelong treatment which will further increase the cost of managing NSI [19]. Overall, the benefit of the intervention far outweighs the incurred cost of managing NSI. The intervention can be sustained as the training could be incorporated into the orientation workshops for the newly employed workers as well as in their routine meetings.

The imbalance between the number of NSIs and usage of post-exposure prophylaxis before intervention in this study may suggest the under-reporting of NSI among nurses. The Ministry of Health and Child Care, Zimbabwe, envisages that all cases of needle stick injuries be reported within 24 hours to the infection control team of the hospital or the head of the department or to the safety and health committee. Although this is the policy, reporting is purely voluntary. Thus the prevalence of the cases remains uncertain, and the magnitude of the problem cannot be accurately determined. This has been reported from previous studies in other countries [9]. According to Bekele *et al.,* on attitude, reporting behaviour and management practice of occupational needle stick and sharps injuries among hospital healthcare workers in Bale zone, Southeast Ethiopia; HCW may also suffer from a false sense of security and may not seek post-exposure prophylaxis [20].

In our study the HBV vaccination coverage was low. All HCW did not receive HBV vaccine. Similarly in most resource-limited settings in Sub-Saharan Africa, despite the long-standing recommendations

for high-risk group vaccination against HBV, it remains unavailable to HCWs, and even when available, the coverage remains low [21].

Our study had some limitations. Intangible and potential costs for managing post-traumatic stress disorder were not evaluated. This might underestimate the pre-interventional effects of NSI in Southern District of Harare city, Zimbabwe. Reliance on self-reported injuries also raises an issue of underreporting. While it was difficult to evaluate the impact of the individual interventions, our study demonstrated the QI approach was effective based on our finding of a significant reduction in the number of sharps injuries experienced by HCWs.

Conclusions and recommendations

The main cited reasons for the increase in NSI incidence were lack of knowledge on the occurrence of NSI, unorganised activities, and limited working space in the treatment rooms. The QI intervention was effective in reducing incidence of NSI. We recommend training of HCWs, deployment of social, behavioural change materials and re-organisation of work environment to mitigate against new cases of NSI to offset economic efforts in managing NSI.

Competing interests

The authors declare that they have no competing interests

Authors' contribution

ZS, CM, KM, PC: conception and design of the study, analysis and interpretation of data, drafting the manuscript. GS, NG, TJ, MT: conception and design of study and critically reviewing the manuscript for important intellectual content. SM, ST, LB, OA: data interpretation, manuscript

writing, and critically reviewing the manuscript for important intellectual content. All authors read and approved the final manuscript for publication.

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Tables and figures

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Table 1: Reasons Associated with Needle Stick Injuries among Health Care Workers in Southern District, Harare City, Zimbabwe, 2017 (N = 83)

Reasons	**Frequency (%)**
Lack of knowledge	82 (99)
Unorganized work activities	50 (60)
Limited space in the room	49 (59)
Recapping of needles	37 (45)
Not using gloves	32 (39)
Long working hours	24 (29)

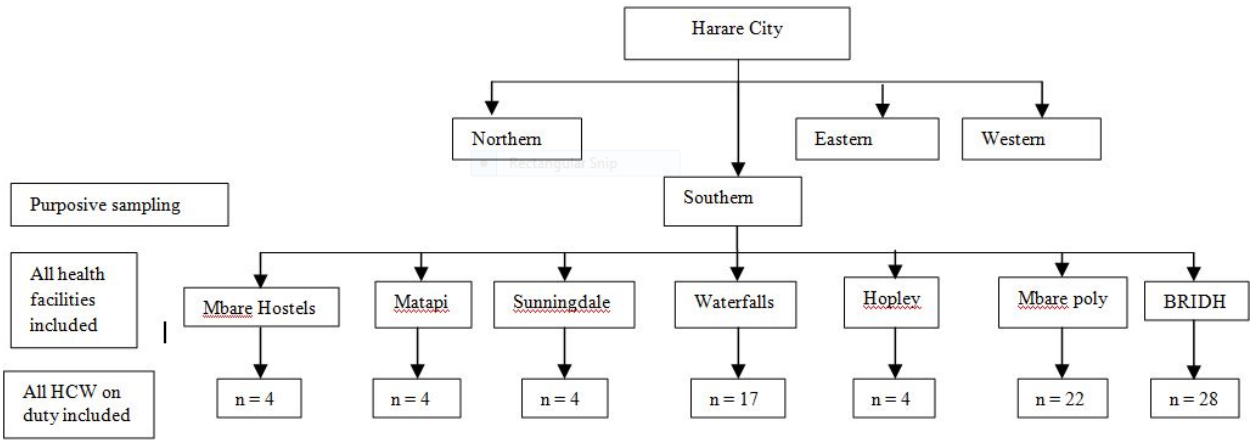
Table 2: The Total Cost Saved by the Intervention over a 6-month Period, Southern District, Harare City, Zimbabwe, 2017

Item	**Unit Cost (US$)**	**Number of NSI**	**Total cost (US$)**
Cost of NSIs 6 month before intervention			
Estimated cost of NSIs	$1300.00	6	$7800.00
Cost of the intervention			
Cost of training 83 HCW	$6.30	83	$523.00
Cost of IEC materials			$200.00
Total cost			$723.00
Cost of a single NSI 6 months after intervention			
Cost of managing NSIs	$1300.00	1	1300.00
Total cost saved bythe intervaention=$7800-($720.00+$1300.00)=$5777.00			

***Total estimated cost of managing a single NSI=$1300**

***Calculated rate of NSI occurrence/ month=0.97**

Table 3: Levels of Knowledge of Health Care Workers on needle stick injuries, Southern District, Harare City, Zimbabwe, 2017 (N=83)			
Knowledge Score	**Knowledge Level**	**Before intervention**	**After intervention**
		Frequency (%)	**Frequency (%)**
0-2	Poor	54	1
3	Fair	36	3
4-5	Good	10	96



HCW: health care workers. BRIDH: Beatrice Road Infectious Diseases Hospital

Figure 1: A flow chart showing the sampling strategy for health facilities and health care workers, Southern District, Harare City, Zimbabwe – 2017

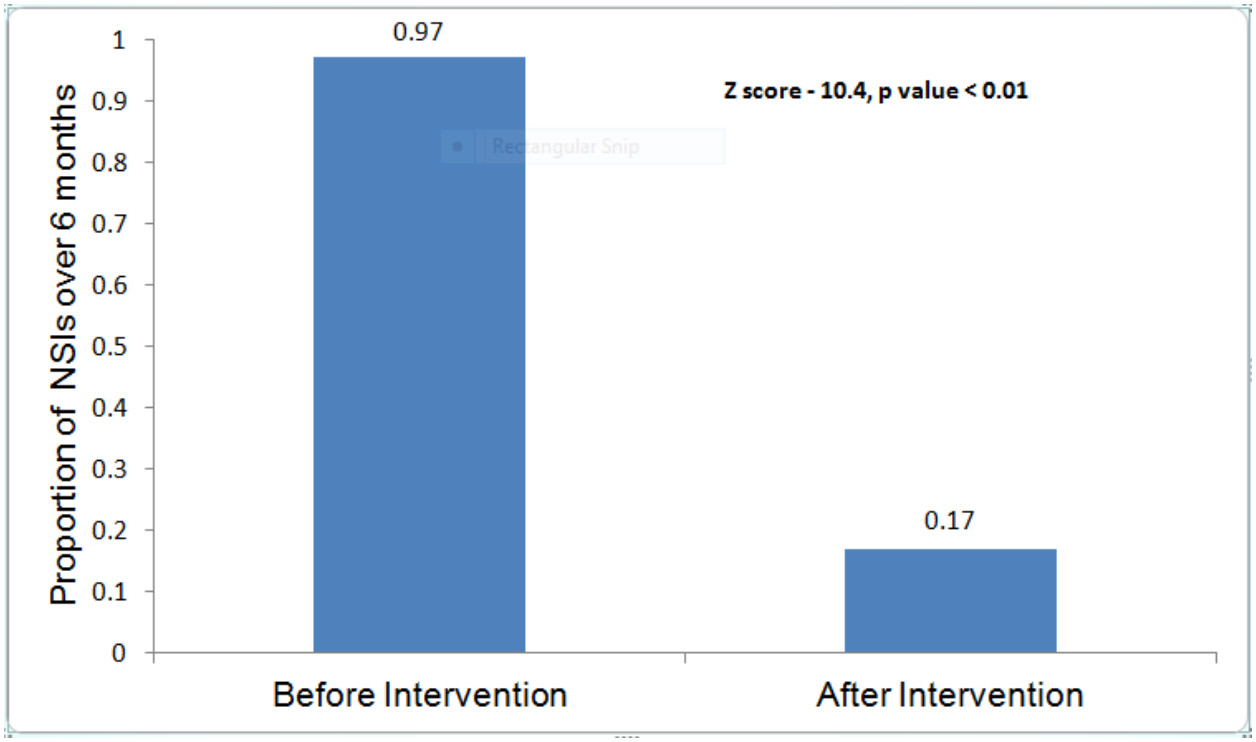


Figure 2: Needle Stick Injuries among Health Care Workers Before and After Intervention, Southern District, Harare City, Zimbabwe – 2017

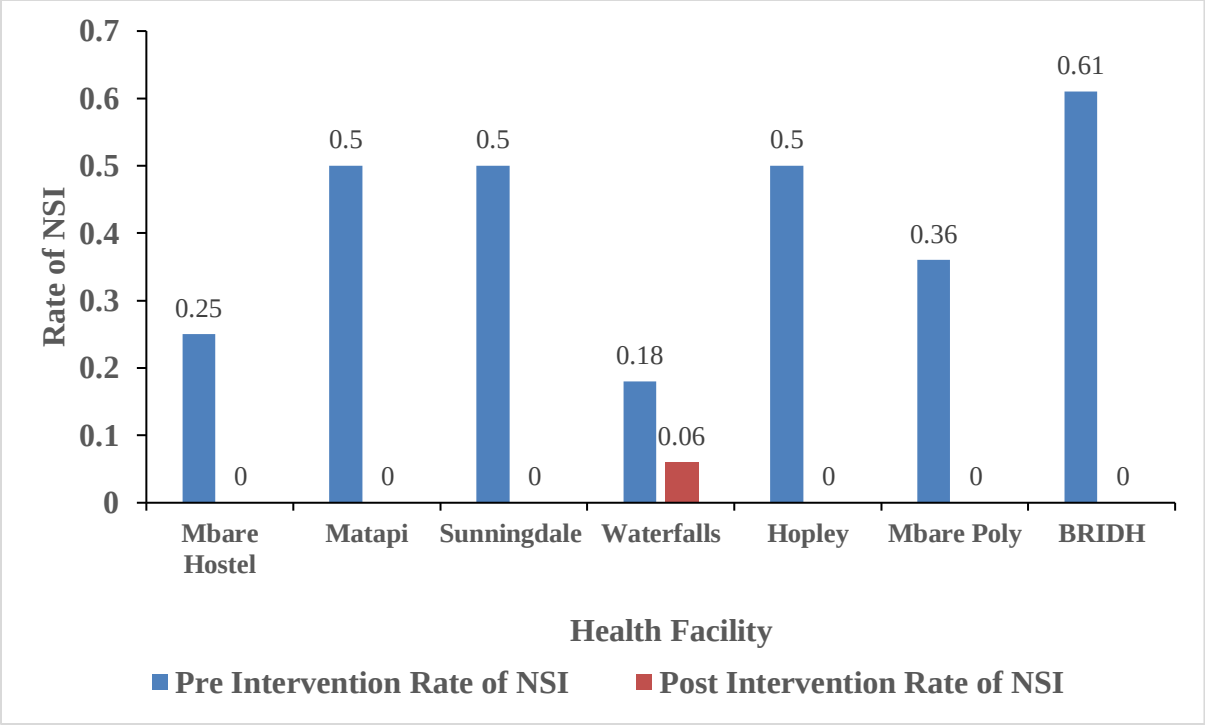


Figure 3: Rate of Needle Stick Injuries Pre and Post Intervention Stratified by health facility, Harare City, 2017