



## Economic Burden of Using Conventional Syringes and Budget Impact of Introducing Safety Syringes in Emergency Departments Across University Hospitals in Egypt

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### Abstract

**Background:** Needlestick injuries (NSIs) represent a serious health problem among health care workers (HCWs) mainly nurses as they are associated with a high risk of infection with blood-borne pathogens including hepatitis B virus, hepatitis C virus, and human immunodeficiency virus which are associated with significant clinical, economic, psychological and societal burdens. Safety syringes were shown to minimize the rate of NSIs and accordingly reduce the associated burdens as well as improve the quality of life of HCWs.

**Objectives:** The main objectives of this study were to assess the economic burden of NSIs in the emergency departments of University hospitals from a societal perspective and to estimate the budget impact of introducing safety syringes to the university hospitals across Egypt.

**Methodology:** This was a cross-sectional observational study where data were collected from 76 nurses from eight university hospitals using a self-administered survey, including 30 questions. The economic burden of NSI was estimated by developing a population-based model, using a hybrid top-down, bottom-up approach. A budget impact analysis was performed to evaluate the impact of introducing safety syringes on a payer budget over a 3-month time horizon. The analysis included the direct cost of NSI associated with both conventional and safety syringes.

**Results:** The study revealed that, with an average NSI rate of 1.3 events per nurse over 3 months and a total cost of EGP 1,773 per nurse, The total economic burden of NSIs associated with conventional syringes usage was estimated to be EGP 11.3 million per 3 months. In addition to the economic burden of NSIs, 70% of the nurses reported experiencing psychological and societal impact associated with NSIs. The budget impact analysis revealed a cost-saving of EGP 4.2 million per three months with the introduction of safety syringes as compared to conventional syringes.

**Conclusion:** Results of the current study suggest that using conventional syringes is associated with high clinical and economic burden while the switch to safety syringes in the University hospitals in Egypt can lead to cost savings by reducing the total number of NSIs.

**Keywords:** Needlestick Injuries; Health Care Workers; Hepatitis

## Introduction

Needlestick injuries (NSIs) are accidental percutaneous perforation of the skin by a hypodermic needle or any sharp object. They are very common among health care workers (HCWs) and represent a serious hazard as they expose HCWs to more than 20 blood-borne pathogens, including human immunodeficiency virus (HIV), Hepatitis C Virus (HCV), and hepatitis B virus (HBV) [1]. The risk of being infected by those pathogens is 6%, 39%, and 37%, respectively, in HCWs [2]. About 32% to 36% of NSIs result from hypodermic injections [1]. Globally, it is estimated that of 35 million HCWs, 3 million experience percutaneous injuries yearly [3].

A study in India showed that around 10.8% of HCWs had experienced different injuries during their duties at university hospitals. Among these injuries, 75% were syringe needles' injuries. More than 100,000 injuries occur in UK hospitals annually [4].

Hepatitis C virus (HCV) is a blood-borne virus that causes liver infection. The vast majority of people who become infected with HCV (70%-85%) develop a long-term, chronic infection that results in serious health consequences, including death [5].

Around 71 million people have chronic HCV infections worldwide [6]. In Africa, mortality associated with viral hepatitis is becoming a more significant threat as compared to mortality related to AIDS,

malaria, or tuberculosis. It is estimated that 10 million people in Africa have HCV infection [7]. Unfortunately, hepatitis C is endemic in Egypt, as it was revealed that Egypt had the highest prevalence of HCV in the world in 2015 [8]. Currently, HCV prevalence in Egypt is estimated to be around 4.5% to 6.7% [9].

No vaccine is available to protect against hepatitis C, and the most efficient way to prevent the disease is to avoid behaviors that can transmit it, especially those related to drug injections [5]. There is a significant risk of infection with blood-borne pathogens such as HCV among healthcare workers after having a NSI in hospitals due to the high prevalence of these pathogens in hospitalized patients [10].

Studies revealed that the use of safety syringes could decrease the risk of NSIs by 43.4%–100% [1]. Thus, Safety Engineered Devices (SED) should be utilized to reduce the clinical, economic, and humanistic burden of NSIs among HCWs. There are limited data available in Egypt regarding the financial burden of NSIs with no information about the impact of using safety syringes in Egypt.

## Objectives

The main objectives of this study were to assess the economic burden of NSIs in the emergency departments of University hospitals from a societal perspective and to estimate the financial

budget impact of introducing safety syringes to the University Hospitals across Egypt.

## Methodology

The burden of NSIs was estimated by developing a population-based model, using a hybrid top-down, bottom-up approach to estimate the direct medical cost associated with NSIs among Egyptian nurses per 3 months. The top-down approach was used to capture the cost paid by the university hospitals, and the bottom-up approach was used to capture the direct medical costs paid by nurses from inside the hospital in addition to their insurance coverage.

Data were collected from 76 nurses in eight university hospitals using a self-administered survey, including 30 questions. The survey covered the journey of a nurse who experiences an NSI starting from first aid, physician consultation, laboratory testing, and treatment if a blood-borne disease is detected and the social impact resulting from the NSI. The data was collected from eight University hospitals, assuming that they represent the emergency departments in all university hospitals across Egypt.

Data on direct medical costs, including first aid, source testing, physician's fees, monitoring, prophylaxis, and treatment of complications, was collected. The survey focused on collecting information on NSIs after injection, assuming that all nurses conducted the same first aid procedure after NSIs. First aid cost was based on the average manufacturer price (AMP).

The NSI burden model estimated the direct cost associated with NSIs such as first aid, physician consultation fees, diagnosis, prophylaxis, and treatment (based on the price list of the public sector). A budget impact analysis was conducted using Microsoft Office Excel 2013 to estimate the impact of introducing safety syringes on a payer budget over a 3-month time horizon in 2019.

Model Inputs	Base-Case Value	Low Value	High Value
Number of NSIs/nurse/3 months	1.3	1.3	1.3
Syringes consumption in 3 months	12,500,000	5,000,000	12,500,000
Conventional syringe Price [11] (EGP)	0.5	0.5	0.70

Cost of source testing (EGP)	130	80	190
Physician consultation fees (EGP)	120	0	150
Cost of HBV Prophylaxis (EGP)	57	30	110
Cost of Wound cleaning [11] (EGP)	0.20	0.20	0.20
Cost of Bandage [11] (EGP)	0.13	0.13	0.13
Cost of HBV test [12] (EGP)	458	458	458
Cost of HCV test [12,13] (EGP)	593	593	593
Cost of HIV test [13] (EGP)	940	940	940
HCV direct cost burden [14] (EGP)	12,500	12,500	12,500
Cost of HBV treatment [12] (EGP)	1,050	1,050	1,050
Cost of HIV treatment [15,16] (EGP)	193	193	193

**Table 1:** Model inputs. EGP: Egyptian Pounds.

## Results

### Economic burden of NSIs among nurses:

According to a recent study conducted by the same university group, 6,366 out of 21,008 nurses (30.3%) would experience NSIs every three months [17]. The incidence of HCV, HBV, and HIV in Egypt is 0.17%, 2%, and 0.004% respectively [18-20]. And according to the WHO, the incidence of blood-borne diseases because of NSIs is 39% for HCV, 37% for HBV, and 6% for HIV [2]. This resulted in an infection rate with blood-borne diseases as a result of NSIs in our study group in three months 0.1% for HCV, 0.6% for HBV, and 0.0002% for HIV.

The study revealed that the average rate of NSIs was 1.3 injuries per nurse per 3 months and the total cost was EGP 1,773 per nurse. And accordingly, the total economic burden of NSIs resulting from conventional syringe usage was calculated as EGP 11.3 million per 3 months in the 6,366 nurses who would experience NSI.

The medical cost (DMC) mainly included laboratory testing cost of EGP 10.9 million (96.45%), treatment cost of EGP 119,630 (1.06%), source testing cost of EGP 169,758 (1.5%), physician visits' cost of EGP 91,408 (0.81%), prophylaxis cost of EGP 18,474 (0.16%) and first aid cost of EGP 1,464 (0.01%) as shown in figure 1.

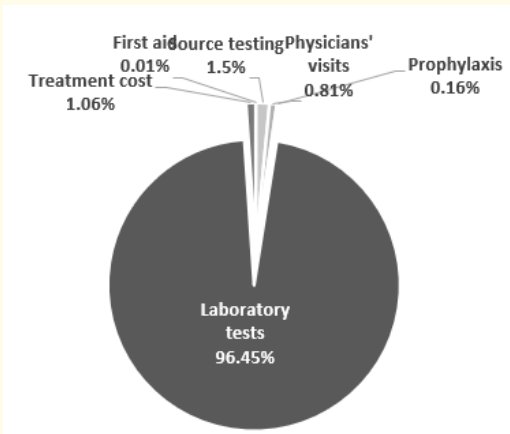


Figure 1: Breakdown of direct medical cost (DMC) associated with NSIs among nurses.

Psychological and social impacts of NSIs

In addition to the economic burden of NSIs, 70% of the nurses experienced psychological and social implications including fear and worry (46%), the tension in family (41%), anxiety and panic attacks (33%), symptoms of depression (28%), crying spells (13%), stress including post-traumatic stress disorder (11%) and adjustment disorder (11%), as shown in figure 2.

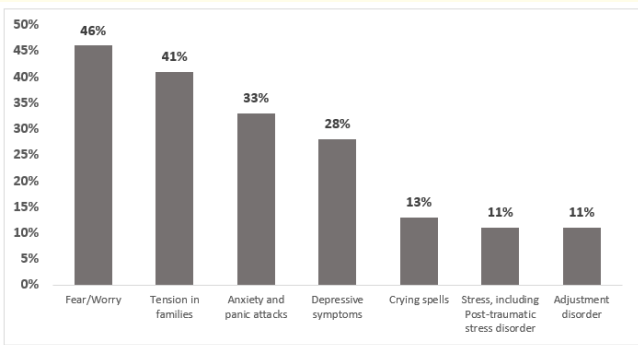


Figure 2: Psychological and Social Impacts of NSIs among nurses.

Budget impact analysis of using safety syringes

Although, the acquisition cost of safety syringes during the three months is EGP 12.5 million and that of conventional syringes is EGP 6.25 million, introducing safety syringes resulted in reducing the number of nurses who would experience NSIs from 6,366 nurses (30.3%) to 454 nurses (2.16%) [17].

Results of the budget impact analysis showed that the reduction in the incidence of NSIs due to the switch to safety syringes would result in a cost-saving of EGP 4.3 million over 3 months period. More details are provided in table 2.

Variables	Conventional syringes	Safety syringes
Cost of devices		
Total number of nurses (n)	21,008	21,008
Assumed Number of used syringes/nurse/ days	10	10
Number of working days/nurse/3 months	60	60
Number of consumed syringes/3 months	12,500,000	12,500,000
Price/syringe (EGP)	0.5	1
Total cost of syringes/3 months (EGP)	6,250,000	12,500,000
Cost of NSIs		
Incidence of NSIs among nurses/3 months	30.3%	2.16%
Number of nurses with NSIs/3 months	6,366	454
Cost of an NSI (EGP)	1,363	1,363
The average number of NSIs/nurse/3 months	1.3	1.3
Total economic burden of NSIs (EGP)	11,283,229	804,349
Budget Impact		
Total cost/3 months (EGP)	17,533,229	13,304,349
Impact on Budget (Total cost of using SS - Total cost of using CS)	-EGP 4,228,880	
EGP: Egyptian pound, NSI: Needle Stick Injury		

Table 2: Budget impact analysis of introducing safety syringes instead of conventional syringes in emergency departments.

One-way sensitivity analysis (OWSA) was conducted for critical variables in the budget impact model to explore the impact of uncertainty on the results. The OWSA indicated that the price of safety syringes has the most significant impact on the results (2%), as shown in figure 3.

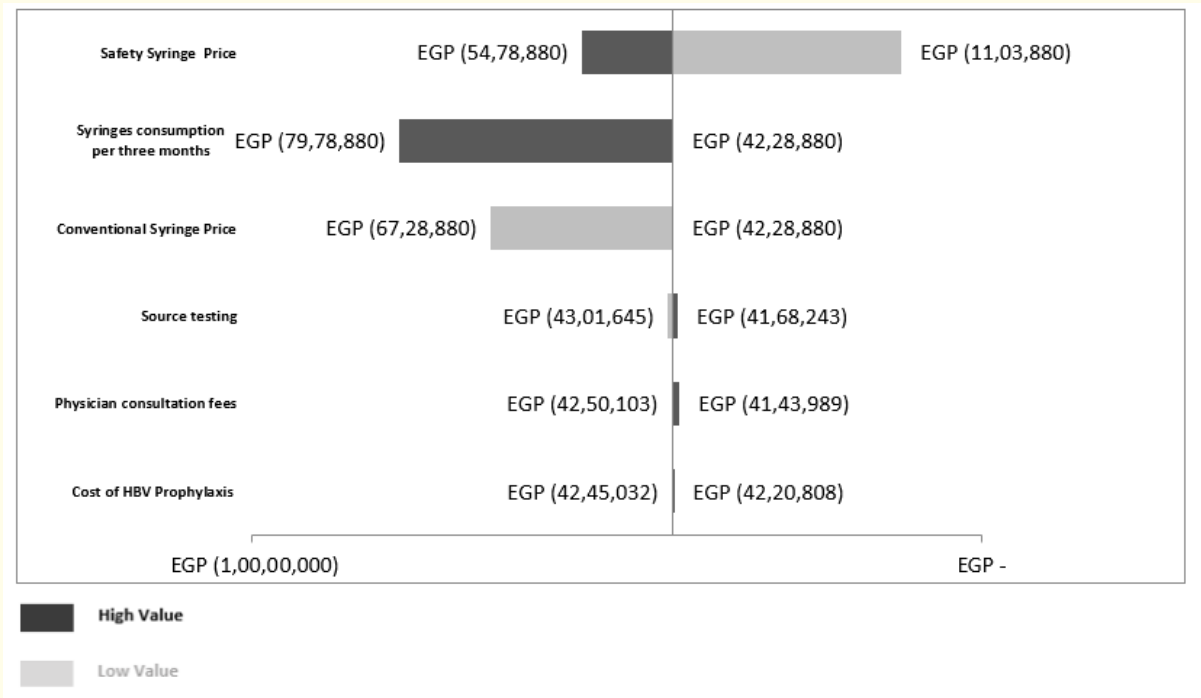


Figure 3: One Way Sensitivity Analysis of the budget impact of using safety syringes instead of conventional syringes.

Discussion

This study showed that the economic burden of NSIs was significant, with a burden as high as EGP 11.3 million per 6,366 nurses who would experience NSIs over a 3-month period. In addition to the economic burden, HCWs experienced severe emotional burden after an NSI experience. The introduction of a safety syringe can reduce the NSI rate as compared to the conventional syringe, and can lead to cost savings of EGP 4.3 million for the 21,008 nurses who work in university hospitals over a 3 months period. Leads to an annual saving of EGP 16.9 million.

NSIs are a crucial element of public health and should be closely monitored as occupational blood exposure puts HCWs at a considerable risk of being infected with blood-borne pathogens such as HBV, HCV, and HIV [21,22]. The rate of needlestick and

sharp injuries among nurses (72.6%) is significantly higher than that among other HCWs ( $p < 0.01$ ), and most of the injuries among nurses (76.8%) result from hollow-bore needles [22].

NSIs mostly occur during recapping and disposal of used syringes and accordingly, comprehensive measures should be developed to minimize the rate of NSIs through avoiding of recapping, using surgical gloves and most importantly, using safety devices (e.g., safety syringes) which will eventually reduce the clinical, economic and psychological burdens associated with NSIs [21]. Recent studies showed that introducing safety syringes instead of conventional syringes resulted in a 64% to 100% reduction in NSIs [23-27].

This cross-sectional observational study was conducted to assess the economic burden of NSIs among HCWs in the emergency

departments of University hospitals and to estimate the budget impact of introducing safety syringes to the university hospitals across Egypt where results were presented from payer perspective as well as nurses' perspective.

The average number of NSI events per affected nurse that was used in the current study, 1.3 NSIs/nurse/3 months, reflects the situation in University hospitals, which is expected to be higher in other non-university hospitals.

This is because the infection control measures followed in University hospitals is more strict compared to other hospitals. Our study estimated the cost of NSIs as EGP 1,773/ nurse per 3 months resulting in a total burden of EGP 11.3 million for the 6,366 would be injured nurses over three months.

Considering the economic constraints in Egypt, budget limitation represents the main challenge against HCV elimination in the country. The challenge includes not only the treatment costs but also the diagnosis costs [28]. And accordingly, the budget impact of introducing safety syringes instead of conventional syringes was analyzed. The study revealed that this massive burden of NSIs could be reduced to EGP 804,349 per 3 months if safety syringes were used instead of conventional syringes as this will result in reducing the incidence of NSIs among nurses from 30.3% to 2.2% with a percent reduction of 93% [17].

It was found that the total cost of using syringes in University hospitals during a period of 3 months (including syringes' price) will be reduced from EGP 17.5 million to 13.3 million with an estimated cost saving of EGP 4.2 million as a result of introducing safety syringes as compared to conventional syringes. This finding is consistent with the results of a recent study conducted in Egypt that revealed that using safety syringes can result in total savings of (EGP-78,924) per person [17]. In addition to the cost-saving, adopting a safety syringe can improve the quality of life of HCWs since the estimated total quality-adjusted life years (QALYs) while using safety syringes was 10.87 compared to 9.20 for conventional syringes (a difference of 1.67 QALYs) [16].

In accordance with these findings, a study conducted in the UK showed that using safety syringes was associated with a decrease in the rate of avoidable NSIs from 11.8 to 0 injuries per 1,000,000 working hours/year which resulted in a significant reduction in the management cost of NSIs including the psychological impact [29].

When introducing safety syringes in the healthcare system, it is essential to consider the preferences of HCWs, which depend mainly on their culture, background, and level of awareness towards the hazards and preventive measures of NSIs. It will be of great value to organize awareness-raising campaigns that target HCWs and the community to highlight the risk of NSIs as well as the importance of using safety syringes as an efficient preventive measure [30].

## Conclusion

The results of the current study suggest that using conventional syringes is associated with a high clinical, psychological, and economic burden that is mainly due to the direct medical cost of NSI management. On the other hand, introducing safety syringes to the university hospitals in Egypt can result in a significant cost savings by reducing the number of nurses experiencing NSIs as well as the total number of NSI events experienced by nurses.

## Conflict of Interest

Other Study authors do not have any conflict of interest to declare.

**Nabil Bayan and Smeet Gala are full time employees of Becton Dickinson**

## Study Limitations

The main limitation of the study is that the data on the management cost of blood-borne diseases' complications, mortality costs, disability costs, and the psychological burden were not included in the burden model, which may have led to an underestimation of the economic burden associated with NSI. Also, the data was collected from 8 University hospitals, assuming that they represent the emergency departments in all Egyptian hospitals, which may give an NSIs' rate that is lower than the actual rate.

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