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A Meta-Analysis Study to Decrease the Incidence of Needle Stick Injuries (NSI) Among Laboratory Staff

MAHMOUD ISMAIL SABER, M.D.

The Department of Clinical and Chemical, Faculty of Medicine, Arish University

Abstract

Background: The incidence of needle stick injuries in our hospital reached a high level by the end of 2022 (28 recorded cases 16 of them inside the laboratory) which is much higher than the average annual rate for a 150-bed hospital as of last year. Further analysis of the problem revealed that Laboratory, operating room staff were the most vulnerable group to such incidents with their health and psychological implications.

Aim of Study: This project aimed to decrease the incidence of needle stick, injuries among laboratory staff, to zero through the implementation of new policies and guidelines, in-service theoretical and practical training, and the securing of high-quality supplies. The success of this project shall be the 1st step in its replication in all hospital areas is to Decrease the incidence of needle stick injuries among laboratory staff to zero and eliminate the related medical, social, psychological & cost consequences.

Material and Methods: Six Sigma DMAIC methodology for quality improvement was used for this project. Using such an effective methodology, causes for needle stick injuries were uncovered, sorted, and analyzed followed by improvement efforts to overcome the gaps in knowledge and safe practice.

Intervention: Our improvement project team employed effective remedies that included implementation of the new policy and guidelines for drawing samples, in-service theoretical and practical training for the newly hired Lab staff together and securing high-quality supplies.

Results: After two DMAIC Cycles and 6 months of implementation of the new policy and guidelines, effective in-service training, and maintaining high-quality supplies, the incidence of needle stick injuries among Lab staff decreased to zero.

Conclusion: Implementation of the new policy and guidelines for drawing samples, effective in-service theoretical and practical training for the newly hired Lab staff together and securing high-quality supplies were effective strategies that allowed the project team to reach its aim. Spreading the project to the whole hospital shall be our future challenge.

Key Words: *NSI: Needle stick injuries – QI: quality improvement – DMAIC: Define-Measure-Analyze-Improve-Control.*

Correspondence to: Dr. Mahmoud Ismail Saber,
The Department of Clinical and Chemical,
Faculty of Medicine, Arish University

Introduction

PROBLEM description and available knowledge, By the end of 2022, 16 incidents of needle stick injuries were experienced by Laboratory staff. Needle stick injuries represent major medical, social, psychological, and cost challenges due to the increased risk of blood-borne infections.

Needle stick injuries (NSIs) are very common occupational hazards among healthcare workers (HCWs) worldwide, especially in high-risk areas like laboratories and operation rooms, these occupational work injury needs to be addressed and represented as sources of infection **[1].** A cut from a contaminated sharp can result in a worker being infected with human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and other blood-borne pathogens. The average risk of transmission after an occupational percutaneous exposure varies by the type of blood-borne virus with the highest risk for HBV at 30% followed by HCV at 3% then HIV at 0.3%v **[2].** In 2007 WHO estimated the annual global needle stick injury at 2 million per year, and the European biosafety network estimated 1 million needle stick injuries annually in Europe. A study by Rogers & Good no in 2000 showed that NSI incidents significantly dropped from 14 to 2 per 100.000 encounters using safety equipment. Another study by Small et al., 2011 **[3]** revealed a decline in NSI incidents with improved communication, education, and sharp containers. Saudi Arabia has long recognized the importance of education to prevent and reduce the risk of infections. Accordingly, the topic was among the top priorities in their nursing curriculum. Sim-

ilarly, Jordan implemented an educational program causing an increase in knowledge and a reduction of infection rates by approximately 50% **[4].**

Rationale:

The quality improvement team for reducing the needle stick injuries employed the Six Sigma DMAIC methodology to reach the real causes of the increased incidence of needle stick injuries among laboratory staff and set an action plan to reduce such incidents **[5].**

DMAIC methodology allowed the improvement team to reach a clear understanding of the problem and workable solutions by using many tools e.g., Flow chart, Cause and Effect diagram among others. A questionnaire was distributed among lab staff to get their feedback regarding the leading causes of Needle stick injuries based on the causes revealed by cause-and-effect analysis **[6]**. These tools helped the team to draw a clear picture regarding the problem, and its root causes, and finally to plan & implement reliable remedies. Clear instructions were in place for post-exposure management, should a needle prick accidentally occur.

Different quality tools have been developed to improve the process and achieve the required Six Sigma quality level. One of these valuable tools and techniques is known as the DMAIC tool (Define, Measure, Analyze, Improve, and Control). Acutely, the DMAIC cycle can be considered a tool for Six Sigma **[7].**

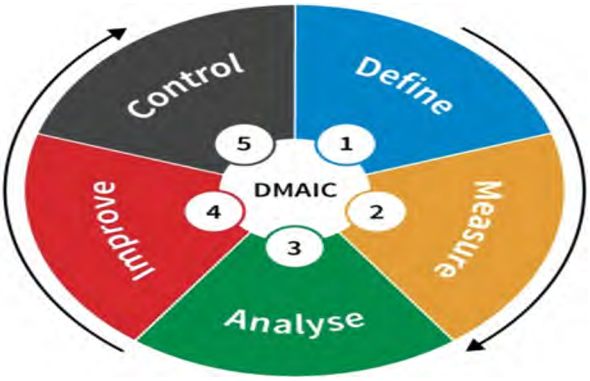

Fig. (1): Six Sigma DMAIC methodology for quality improvement of needle stick injury in PMMH.

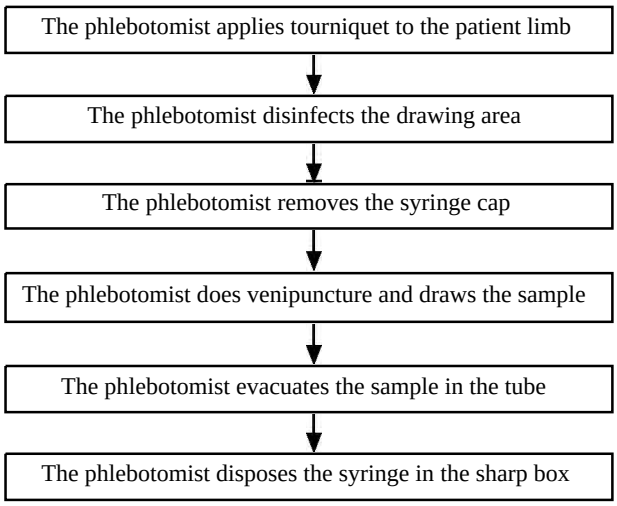

Fig. (2): Flow chart for a blood sample.

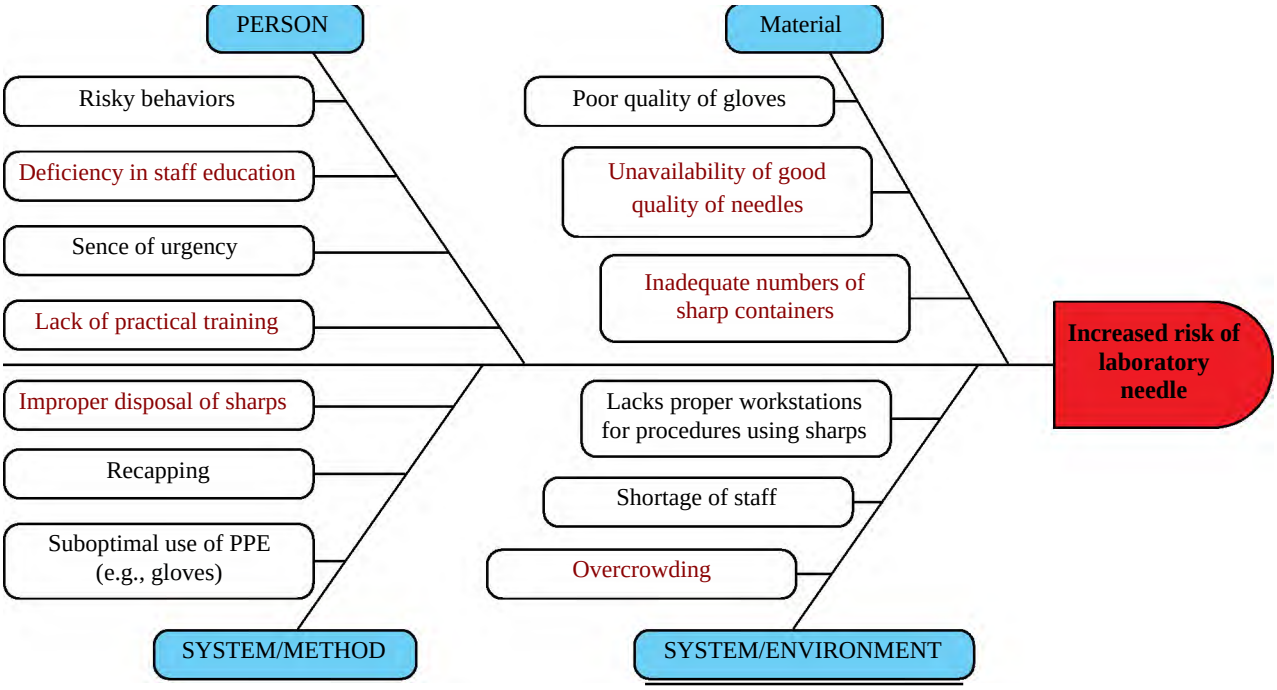

Fig. (3): Fishbone diagram for main causes of needle stick injury.

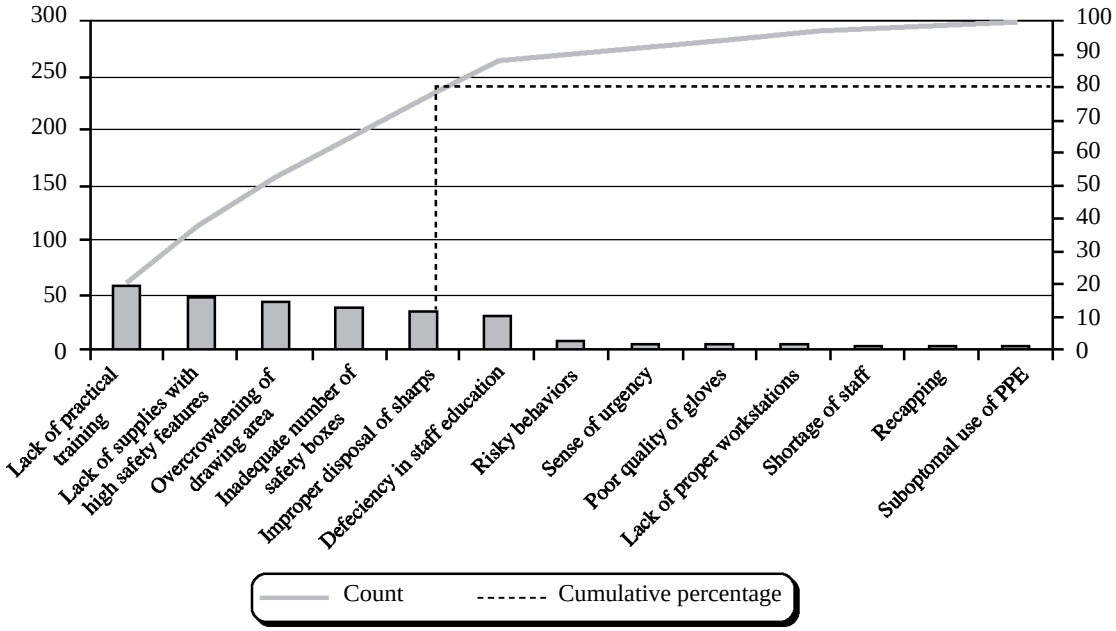

Fig. (4): Pareto tool for the main causes of needle stick injury.

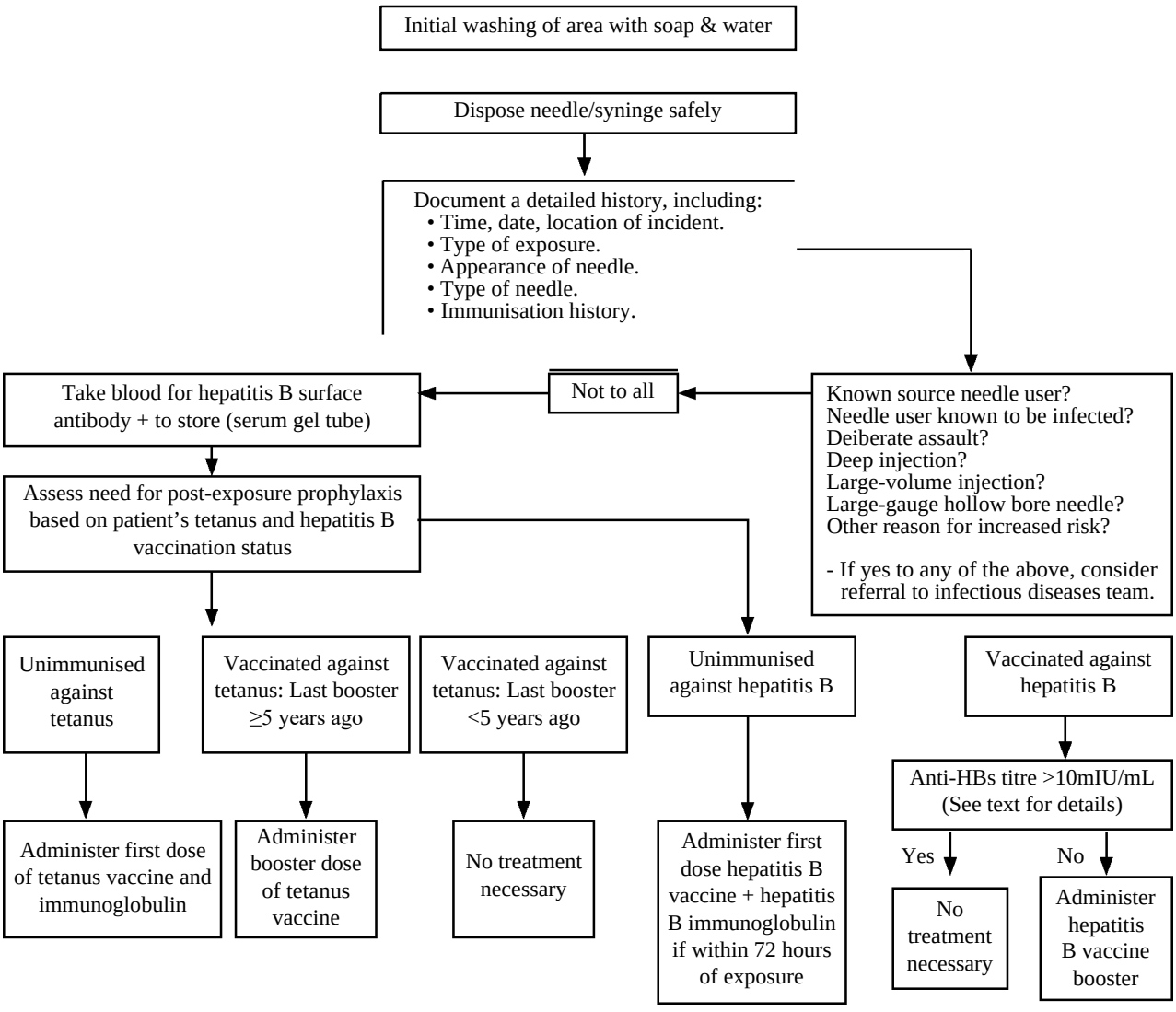

Fig. (5): Post-exposure management diagram.

Patients and Methods

Context The clinical laboratory of Sednawy Hospital conducts more than 2000000 laboratory tests annually, with the average number of patients sampling 100000. Many of these tests are based on blood samples withdrawn from patients by phlebotomists. Newly hired laboratory staff have to be enrolled in training during their probationary period before they can start to work independently. Before the start of this project, the average duration of training was one month.

It should be denoted that Laboratory staff have a long journey with quality as related to their extended history with quality control for lab tests & reagents together with proficiency testing. This quality-driven environment is much supported by dedicated lab-quality officers.

Nevertheless, our improvement effort is not apart from trying to keep in compliance with governmental efforts to improve working conditions and to reduce risks encountered by staff as described in the manual for Physical Work Environment endorsed by the Ministry of Civilian Service.

Interventions A multidisciplinary team was assigned to run this project.

In-service theoretical and practical training for three months was conducted for newly hired and old laboratory staff that was done by senior laboratory staff in coordination with the infection control department. Multiple training methods were employed including theoretical lectures, practical training, illustrated booklets, and Hands-on workshops. Guidelines for withdrawal of samples were updated and communicated to relevant staff. Important components that were emphasized within the guidelines included the implementation of two to five minutes of patient complete rest before blood drawing, preparation of all the requirements for blood drawing during the time of patient resting, following standard precautions before drawing blood, following the right procedure for the patient sitting and relaxation and the angle for needle blood drawing, checking the required equipment before the beginning of the procedure, special precautions and getting the help of an assistant in case of blood drawn from children, **[8]** proper disposal of waste and prevention of recapping **[9]** Removal of unnecessary equipment from the drawing area together with strict rules to minimize the number of staff in the drawing areas. Enough amounts of high-quality new vacutainer systems were secured with a satisfactory number of safety boxes to dispose of needles. Clear instructions were prepared to help staff in post-exposure management should needle stick injury accidentally occur.

Study of the Intervention(s):

To measure the perception of the interventions on Laboratory staff and the effects of such interventions on the outcome, a survey was administered in the laboratory at the start of the project and 6 months later. The survey included closed-ended questions related to the transition materials (usefulness of the guidelines and training, actual use of guidelines, and impact on the workflow). We also got open-ended feedback. Regular audits were conducted to monitor laboratory staff compliance with the new guidelines and procedures **[10].** Needle stick injury reports received by the infection control and continuous quality improvement departments have been used to assess the outcomes of the intervention. Significant changes in Average Turn Around Times (TAT) for certain laboratory tests were used as a balancing indicator to show any unintended outcomes as a result of interventions.

Quantitative Measures:

1- The compliance rate of laboratory staff with new guidelines and procedures (Process measure) through observation audits.
   - No. of totally compliant observations/total No. of observations*100.

2- Needle stick injuries related incidents (Outcome measure) through NSI reports to infection control and Quality improvement departments.
   - No. of reported Needle stick injuries related incidents involving laboratory staff.

3- Percentage of outliers for TATs for CBC, chemistry & renal function tests.

Balancing measure:

Data for measures were reported monthly:

Qualitative measures:

Survey to measure the perception of the interventions on laboratory staff and satisfaction with training, guidelines, and available supplies at the beginning of the project and 6 months later.

Analysis Line graphs were used to display staff compliance rate with guidelines, several needle stick injury-related incidents and the percentage of TATs outliers.

Bar graphs were used to display the results of surveys on the perception and satisfaction of laboratory staff.

Ethical considerations:

No conflicts of interest existed. This project was initiated after approval of the team charter by the hospital Quality and patient safety committee.

Acknowledgements: The project team would like to acknowledge the cooperation of the laboratory administration and Material management department.

Results

Key improvement areas and specific interventions of our project are listed in the following Table.

Key improvement area	Improvement step	Improvement group
- In-service training	- Theoretical lectures for phlebotomists	• Senior lab staff • Infection control practitioners
	- Practical training	• Senior lab staff for phlebotomists
	- Hands-on workshops	• Senior lab staff
	- Illustrated booklets	• Infection control practitioners • Infection control practitioners
- Guidelines for drawing samples	- Revision of existing guidelines against the available literature	• Lab director • Lab Quality officers • Infection control head
	- Updating guidelines	• Lab director • Lab Quality officers • CQI department
	- Communication of guidelines to phlebotomists	• Infection control head • Infection control staff • Lab Quality officers
- Minimization of crowdedness in the drawing areas	- Removal of unnecessary equipment from the drawing area	• Lab director • Lab Quality officers
	- Strict rules to minimize the number of staff in the drawing areas	• Lab director • Lab Quality officers • Material management department • Infection control head • Lab director
- Adequate amounts of safety supplies	- Securing of new vacutainer system	• Material management department
	- Securing safety boxes	• Infection control head • Lab Quality officers
	- Daily check of all requirements for blood draws	• Lab Quality officers
	- Weekly check of laboratory store of needle-sharp containers'	
- Post-exposure management guidelines	- Post NSI exposur protocol reinforcement for phlebotomists	• Infection control practitioners

During the 1st phase of the project (JAN-MAR 2023), then in the service training program was launched and included in-service practical and theoretical lectures & hands-on workshops and simulation. Guidelines were updated and communicated to staff as a part of the training program. These guidelines considered precautions during the drawing of samples together with a protocol for the management of post-exposure, should an incident occur. Crowdedness of drawing areas was addressed through strict rules and the removal of unnecessary equipment. A survey was conducted at the end of the training program. The survey included closed-ended questions related to the transition materials (usefulness of the guidelines and training, actual use of guidelines, and impact on the workflow). The survey included open-ended feedback.

During the 2nd phase of the project (APR-MAY 2023), illustrated booklets including guidelines were prepared and distributed among relevant lab staff, audits for monitoring of guidelines implementation started, improvement initiative was enforced by securing enough amount of safety supplies (new vacutainer system and sharp container safety boxes) that was kept always at satisfactory levels through regular checks.

Another survey was conducted 6 months following the 1st survey to measure the perception of the interventions on Laboratory staff and the effects of such interventions on the outcome.

During the sustainability phase, we continued to monitor our process, outcome & balancing indicators **[11]**.

Monitoring of lab staff compliance with guidelines showed progressive improvement in staff compliance that ranges from 65% at the start of the project to 87% 6 months later. These results are much correlated with results from the staff experience surveys that were conducted after the end of the training program and 6 months later.

No incidents of NSI have been recorded among lab staff since the start of our project till the moment.

Monitoring of the percentage of TAT outliers revealed no significant difference between results dated before and after our intervention with the disease the main act of the video

It should be noted that the involvement of representatives from different levels of the laboratory organizational chart had a noticeable impact on the outcome as informed by open feedback from lab staff through staff experience surveys.

We had no accurate data about estimated cost savings as a result of our interventions as the data for costs incurred for management of preceding incidents are deficient.

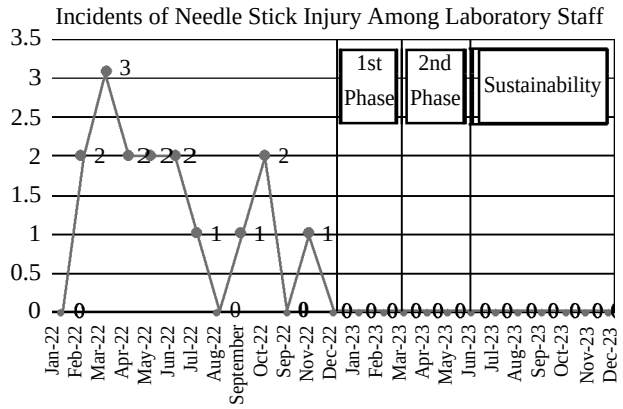

Fig. (6): Incidents of needle stick injuries among lab staff.

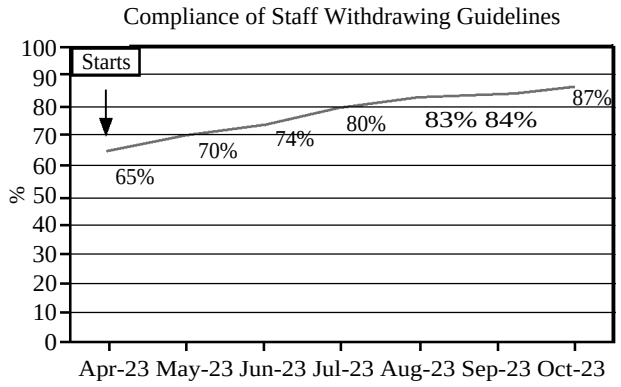

Fig. (7): Compliance of staff withdrawing guidelines.

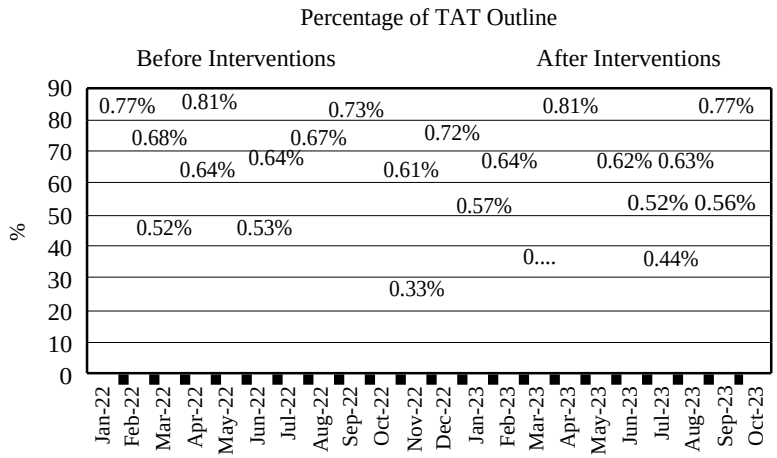

Fig. (8): Results from staff experience surveys.

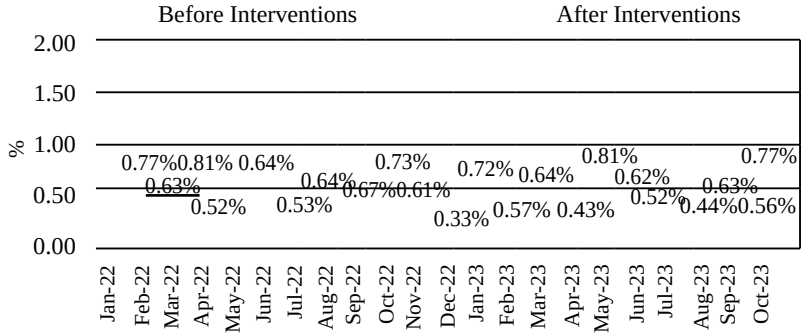

Fig. (9): Percentage of TAT outliers.

Discussion

Summary in this project, we started with 4 needle stick injury incidents among laboratory staff during the preceding year then our QI team started to implement an action plan that included integrated training, clear instructions, and improving the work environment and tools. NSI incidents decreased to zero and that level was sustained till this moment. This project involved a multi-dimensional approach towards a multifactorial problem.

After QI interventions, the NSI incidents among lab staff decreased to only one (zero) case for 12 months duration. Theoretical and practical training, new guidelines, and continuous availability of enough safety supplies (e.g. new types of vacutainer needles for blood drawing) together with the improvement of the working environment enabled our QI to reach its aim.

Our results are in agreement with the results from a study by Rogers & Good no in 2000 that showed a significant drop in NSI incidents from 14 to 2 per 100.000 encounters through the use of safety equipment. Our findings are also comparable with a study by Small et al., in 2011 that revealed a decline in NSI incidents by more than 50% with improved communication, education, and sharp containers.

We learned in this project that front-line staff engagement and staff awareness about the problem and its volume are very important factors in achieving the required result. It was clear that lab middle management represented by supervisors and quality officers much influenced our achieved results. In addition to that, this project improved communication between different departments (e.g. laboratory, infection control, MMD, and quality) where all of these departments cooperated to solve the problem and reach our aim.

Although the success of our work gives us the impetus to continue our efforts in all hospital areas, gaining the same results in another context will be highly determined by the involvement of leaders and supervisor-level staff in these areas together with the continuous provision of needed resources.

The limitation of our study was the context of the Laboratory itself as a high-quality-oriented environment with lab staff being accustomed to using work instructions and guidelines and that context greatly affected the success of efforts and reaching the level of zero incidents that was sustained for 12 months duration. Replication of our results could be very challenging in different contexts.

Conclusions:

We have found that needle stick injury incidents can be reduced in the laboratory area through employing an integrated educational program, and implementation of a new set of instructions. Staff education is a very important part where it helps staff to build their knowledge in regards to needle stick injury prevention. Prevention of needle stick injury incidents helps save organizational resources and decreases the possible consequences of post-needle stick injury infection like social, psychological, and cost. Due to our success in achieving our target, spreading the project to the whole hospital is our future challenge.

The sustainability of low-level needle stick injury incidents highly depends on the compliance of staff with the new guidelines and procedures and the continuous support of hospital administration by maintaining the availability of required resources.

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دراسة بحثية لتقليل نسبة الوخز بالابر الملوثة بين العاملين فى المختبرات الطبية

الوخز بالإبر الملوثة من أكثر المشكلات التى تواجه العاملين فى المجال الصحى لما لها من خطورة الإصابة بفيروسات الدم والتى تؤدى إلى الالتهاب الكبدى الوبائى وما له من مضاعفات صحية واجتماعية ومادية ناتجة عن ذلك مما يؤثر على صحة وإنتاجية العاملين فى المجال الصحى.

ويعتبر العاملين فى المجالات الجراحية والمختبرات وسحب العينات والحقن هى الفئات الأكثر عرضة للإصابة بالوخز بالإبر الملوثة.

ويهدف البحث إلى استخدام أدوات الجودة والطرق العلمية الحديثة إلى للوصول لأهم الأسباب المؤدية إلى الإصابة بالوخز بالإبر الملوثة وكيف منعها وعلاجها وطرح الحلول المناسبة لتقليل نسب الإصابة بالوخز بالإبر إلى اقل حد مسموح به .

وتعتبر طريقة CYCLE DMAIC إحدى أدوات الجودة الحديثة ومن أفضل الطرق العلمية لمعرفة أسباب مشكلة الوخز بالإبر ووضع حلول مناسبة لمنعها وعلاجها وتقليل المضاعفات الناتجة عن هذه المشكلة على الممارسين الصحيين المعرضين للوخز بالإبر.

ولذلك نوصى باستخدام الطرق العلمية وأدوات الجودة الحديثة فى اكتشاف الأسباب الأساسية ووضع الحلول المناسبة للمشكلات التى تواجه العاملين فى مجال المختبرات الطبية وخاصة طريقة CYCLEDMAIC فى التعامل مع المشكلات التى تواجه العاملين فى قسم المختبرات عند الوخز بالإبر الملوثة.