Impact of Lean Strategy Utilization Training program on Quality of Environmental and occupational safety.

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Abstract

Background: There is a great concern about overlooking occupational, health and safety issues while lean implementation at the workplace due to its valuable effect on improving operational processes and reducing negative outcomes. **The study aim:** To determine the impact of a lean strategies utilization training program on quality of environmental and occupational safety. **Research design:** Quasi-experimental research design. **Setting**: The study was conducted at all El-Mansoura University Hospital inpatient (medical, surgical, and emergency) units. **Subjects:** All the head nurses (N=22), and all staff nurses (N=172) who were working in the previously mentioned units and who were available at the time of data collection. **Tools**: Three tools were used for data collection, Tool (1): Lean Knowledge Assessment Questionnaire. Tool (2): Environmental and Occupational Health and Safety Observation Checklist, and finally Tool (3): Value Stream Map (VSM). **Results:** There was a statistically significant relation between lean utilization training program and quality of environmental and occupational safety of staff nurses. There was a highly statistically significant difference between study subjects` knowledge regarding lean strategies at pre and post program. There was a highly significant negative correlation between total quality of environmental and occupational safety of staff nurses and total occupational hazards. **Conclusion**: There was an improvement in study subjects` knowledge regarding lean strategies post-program compared to pre-program. Also, there was a marked decrease in time and frequencies exposure to occupational hazards during medication administration post-program while, there was a marked increase in quality of care during medication administration post implementation of the program. **Recommendations**: Improve the organizational readiness for lean strategies implementation through: introduce lean approach in the healthcare settings plans as well as vision, and enhance leadership behaviors, abilities and commitment to lean principles and encourage staff contributions to continuous quality improvement.

Keywords: Lean strategy, Quality of care, Occupational safety, Environmental hazards, Value Stream Mapping.

Introduction:

Since the creation of the Lean Production (LP) concept in Japan by Toyota after World War II, considerable analyses have been conducted about it (Holweg, 2007). Toyota production executive the concept of Lean methodology during the early 1940s in response to production issues at his Toyota manufacturing facility in Japan (Angela et al., 2019). A definition is given by Ohno who describes lean as eliminating waste from the production system (Ohno, 1988). Lean is a set of operating philosophies and methods that help creating a maximum value for patients by reducing waste and waits. It emphasizes the consideration of the customer's needs, employee involvement and continuous improvement (Lawal1 et al., 2014). Lean principles refer to an overarching set of principles aimed at transforming workplace culture (Kruskal, 2012). The principal idea behind lean methodology is to eliminate the waste, to provide what the customers value with minimum resources; to shortening the total time cycle from work processes, to increase quality, and to lower costs. It is both a tool set and a management process (Poksinska, 2010). Accidents result in reduced efficiency of a process, resulting in non-value-adding events in a production system. Since lean principles aim at reducing waste, it would be prudent to assume that the reduction of occupational hazards is a naturally occurring outcome of the implementation of lean construction principles (Wu, 2019). The creation of a lean environment

in a workplace requires employee motivation and good management. All the different levels of an organization need to put forth their best efforts on a day-to-day basis and work together toward achieving improved performance and reducing waste, thus productivity, quality and safety will be improved effectively(Anvari et al., 2011).

Health care systems as a whole face many difficulties, including, increased demand, new technology and expensive service, high rates of medical errors, suboptimal quality and low operating efficiency. In this context, providing high quality services and meeting patient expectations with minimum resources is a major challenge, which has driven some healthcare organizations to explore whether lean methodology which primarily focuses on improvement by reducing waste may be able to help.(Kelendar et al., 2020) Lean principles today focus on continuously identifying improvement opportunities by eliminating waste in the form of any non-value-added activities in the value stream process, and creating value-added activities. (Jadhav et al., 2014). Lean methodology has several tools e.g., Value Stream Mapping, 5S, Kanban, Standardization and Process Map. Commonly, lean tools are used for two purposes: to identify and analyze the existing waste (early stage) and to remove the identified waste (final stage) (Awang and Yusof, 2017). Using lean tools, all members of the organization, from clinicians to operations and administration staff, continually strive to identify areas of waste and eliminate anything that does not add value for patients **(**Rutman et al., 2015).

The most common famous lean tool used was Value Stream Mapping (VSM) which is a tool (diagram) that is used to help in seeing and understanding the flow of material and information on a product in the value. (Cohen, 2018) This tool was generally used to illustrate a process' flow and identify waste, as it explicitly shows the whole process from the beginning to the end for all parties. This provides opportunities to visualize the steps that do not add value and identify ways in which valuable steps could be made more efficient (Mazzocato et al., 2010). Value stream analysis can identify three types of actions throughout the value stream, namely: a) Value-Added, Activities or processes that produce value. b) Necessary but Non Value-Added, Phase that does not produce value but cannot be avoided with existing technology and resources. c) Non Value-Added, phase that does not produce value and can be avoided (Usman, 2020).

Lean has the potential to reduce errors in both patient/staff safety (e.g. errors regarding drug administration) and resource utilization (Rotter, 2017). By implementing lean in healthcare and reviewing processes and systems through the lens of the wastes and hazards, organizations can potentially: Reduce patient waiting time, eradicate defects to improve quality of care such defects as; medication errors or running around to gather supplies that increase the risk of patient/caregiver injury, save time by reducing motion, remove waste from over-processing and over-production **(**Rutman et al., 2015). Hence, lean occupational safety and health is one of the techniques that reduce workplace hazards and risks if properly thought in hospitals. The importance of work place safety and health hazards improvement is on how to control its severity from its risks, considering how to reduce or eliminate non-value adding wastes from health sectors. Safe workplace and safe work is necessary for reducing those suffers and increasing productivity; hence promotion and protection of safe work and workplace is the complementary aspect of health organization development (Jilcha & Kitaw, 2016).

Significance of the study:

Improving occupational safety in health organization remains a priority and is critical in the context of improving organization productivity, efficiency and for more economic benefit. Lean strategy is needed for hospital in order to meet patient needs optimally, to be able to provide health services as much as possible to patients by reducing waste, and to create added value for the hospital (Tortorella et al., 2017). The improvements of lean utilization were mostly related to the patient outcomes, represented by shorter treatment times, increased patient satisfaction and more accessible care. Lead time reduction as a target measurement was a primary goal of lean

implementation (Abdelhadi & Shakoor 2014). Obtaining head nurses` support and their involvement in the lean initiative is a vital factor for successful lean implementation in healthcare regardless of the intervention type (Tortorella et al., 2017). Therefore, the purpose of the present research is to evaluate the impact of lean strategies utilization training program on the quality of environmental and occupational safety.

Aim of the study:

To evaluate the impact of lean strategies utilization training program on the quality of environmental and occupational safety.

Research Hypotheses:

The lean strategy utilization training program, will have a positive impact on quality of environmental and occupational safety.

Materials and Methods:

Research design: Quasi- experimental research design was utilized to conduct this study.

Setting:

All in-patient units: medical, surgical, and emergency units at El-Mansoura Main University Hospital. This hospital is one of the largest Main University Hospitals in Delta and Lower Egypt region which is affiliated to the Ministry of Higher Education and it contains Quality and Occupational Health & Safety units.

Subjects:

It will include all the head nurses (N=22), and all staff nurses (N=172) who are working in the previously mentioned units and who were available at the time of data collection.

Tools of data collection:

Three tools were used for data collection:

Tool 1: Lean Knowledge Assessment Questionnaire:

This tool was included two parts as follows:

Part (1) was including: Demographic data sheet included questions related to: age, gender, marital status, qualification, years of experience.

Part (2): Lean Knowledge Assessment Questionnaire was developed by the researcher based on the review of related (Abu Bakar & Ahmad, 2010; Canipe, 2010; Holden, 2011; Anvari, Zulkifli, & Yusuff 2011; Holt & Vardaman, 2013; Pai, 2014). It is used to assess head nurses and staff nurses` knowledge, as pre/post-test regarding lean concepts, strategies, principles …, etc. It consists of 18 items regarding; concept of lean management (2 items), aims of lean (3 items), strategies of lean (4 items), obstacles of lean management (3 items), types of lean (2 items), principles of lean (2 items), lean process (2 items). The response for each item was either "correct/complete", "correct/incomplete" and "incorrect or no response". ***Scoring system:*** a score of (3) was given to the correct/complete answer, a score of (2) was given to correct/incomplete answer and (1) score was given to incorrect or no response. The responses were scored then summed together and the total score was ranged from 18 to 54 which categorized into three levels as the following: <50 % indicate Poor knowledge, (50 - <75 %) Fair knowledge, and (≥75 %) indicate Good knowledge.

Tool 2: Environmental and Occupational Health and Safety Observation Checklist.

This tool was developed by the researcher based on intensive reviewing of related literature (Brandao, 2009; Jimmerson & Jimmerson, 2010; Calderone, 2012). It was designed within the framework of Gemba Walk development strategy (Hafer, 2012; URT-MOHSW, 2013; Ferraro, 2014; Ochieng, 2015; Yaseen & Paules, 2015) to observe and assess: time & quality of care, and application of environmental and occupational safety by staff nurses, regarding medication administration process, and utility systems.(as pre/post-test) It included the following three parts:

Part (1): Time (min) of medication administration:

It is used to measure time of medication administration. It consisted of 8 items and the response for each item was either "done completely", "done incompletely", and "not

done". ***Scoring system:*** a score of (3) was given to done completely, a score of (2) was given to done incompletely and (1) score was given to not done. The responses were scored then summed together and the total score was ranged from 8 to 24 which categorized into three levels as the following: <50 % indicate Low, (50 - <75 %) indicate Fair, and (≥75 %) indicate High.

Part (2): Quality of care during medication administration:

It is used to measure quality of care during medication administration. It consisted of 7 items scored on three responses; completely done, partially done and not done. ***Scoring system:*** a score of (3) was given to completely done, a score of (2) was given to partially done, and a score of (1) was given to not done. The total score ranged from 7 to 21, which were divided into 3 categories: <50 % indicate low quality, (50 - <75 %) fair quality, and (≥75 %) indicate high quality.

Part (3): Occupational hazards during medication administration:

It is used to measure the levels of environmental and occupational hazards associated with medication administration. It consisted of 10 items scored on three responses either; completely present, partially present, and not present. ***Scoring system:*** a score of (3) was given to completely present, a score of (2) was given to partially present, and a score of (1) was given to not present. The total score ranged from 10 to 30, which were divided into 3 categories as the following: <50 % indicate low, (50 - <75 %) Fair, and (≥75 %) indicate high.

Tool 3: Value Stream Map (VSM)

This tool was developed by the researcher based on the review of related literature (Tsasis & Barrett, 2008; Solanki, 2010; Omachonu & Einspruch, 2010; Canipe, 2010; Martin & Osterling, 2014; Langstrand, 2016). VSM was used to visualize, document, analyze and improve the flow of information required to improve service for patients. It was used to reduce cycle time of medication administration process by analyzing the observation obtained from previous Tool 2 in identifying wastes in the process the current state and designing a future state for the series of events that take a service from its beginning till the end of the process.

In addition: Post-Intervention Reaction Questionnaire: Head nurses and staff nurses reactions to program questionnaire to reveal their satisfaction toward the program after its implementation related to: objectives, time period, contents, time schedule, and method of teaching of the program.

Validity and reliability:

Tool 1 and 2 were tested for content validity by five experts from Damanhour University; and accordingly modifications were carried out according to the panel judgment on clarity of the sentences and appropriateness of the contents. Reliability of the tools were established through test re-test correlation co-efficient with 15 days interval. Both tools proved to be highly reliable, the Cronbach's Alpha for tool 1 r = 0.902 and for tool 2 r = 0.801.

Pilot Study:

The pilot study was carried out on 3 head nurses and 18 nurses who represent (10%), rather than the study samples. It was conducted to assess the applicability, clarity, and feasibility of the study tools.

Fieldwork:

Data collection of the study was started at the beginning of March 2019 and completed by the end of April 2019. Follow up started from the beginning of August 2019 to the half of September 2019. The researchers contacted the subjects at their workplace at the hospital hall, after dividing them into three equally in number groups. Each group was trained for eight consecutive days including: theory and practice. Each training day last for three hours with a break. It was conducted through assessment, planning, implementation, and evaluation phases.

Phase 1: Assessment phase:

- Data were collected after obtaining an official agreement from the director of the studied hospital. Meeting with the director of nursing service was also conducted on an individual basis to explain the objectives of the study and to gain her cooperation.

- Assessment was carried out before developing or implementing the training program, by the researcher and her trained assistants to collect data about head nurses and staff nurses and it will focus on the following:
- Tool 1: Lean Knowledge Assessment Questionnaire; was used to assess head nurses and staff nurses ' knowledge regarding lean concepts, strategies, principles and lean obstacles. Knowledge test (pre-test) was administered to head nurses and staff nurses.
- Tool 2: Environmental and Occupational Health and Safety Observation Checklist; was designed to observe and assess quality of environmental and occupational safety by nurses, associated with medication administration (pre-test) through covert observation.
- Tool 3: VSM is an analytical tool of lean assessment activity that analyze the observation obtained from previous Tool 2 in identifying wastes in the process the current state to reduce cycle time of medication administration.

Phase 2: Planning and development phase:

- Planning and development of the lean strategies training program for the studied subjects based on the result of the assessment phase and the program included: general and specific objectives, relevant content, using educational methods as: interactive lecture, discussion, and group work as well as data show, flip chart and videos.
- Evaluation techniques, pre-and post-test of each session of the training program.

Phase 3: Implementation phase:

- Before the conduction of the training program for head nurses and staff nurses, permission was obtained from the hospital and nursing service directors.

The training program was implemented and the following educational methods were utilized: lecture, discussion; brainstorming, and group-work. The time of the program was eight working days for all subjects; the program was divided into five days for theoretical contents and three days for practice lean activities. The theory encompassed: objectives, content, teaching strategies and evaluation techniques pre-and post-test. Each day of the training program was divided into two sessions, the duration of each session was 75 minutes, a break for 30 minutes was arranged between each session**.** Each training day started from 10 A.M to 1 P.M.

Phase 4: Evaluation phase:

Evaluation was done three times in relation to the training program. First, before the beginning of the program. Second, immediately after the program and finally, three months after the program conduction in order to validate the effect of implementing the lean strategies by the study subjects on quality of environmental and occupational safety, using the following techniques:

- Participants' reaction questionnaire was distributed to head nurses and staff nurses immediately after program implementation to reveal their reactions and level of satisfaction toward program.
- Head nurses and staff nurses were given enough time to answer the questions (20 minutes).
- Knowledge assessment after training program using post-test was distributed again to head nurses and staff nurses at the end of the program to evaluate the gained knowledge in comparison with the pre-test.
- Covert observations were undertaken again for the head nurses and staff nurses immediately at the end of the training program and after 3 months later from program implementation, to collect data to assess changes in performance of staff nurses in medication administration safety process, utility system management and quality of occupational and environmental safety.

Ethical Consideration

- The research Approval was secured from the ethics committee in the Faculty of Nursing, Damanhour University.
- The researchers have clarified the aim of the study to head nurses and nurses included in the study before starting.

- Oral consent was taken from each participant. They were informed that the data collected will be used for the research only, and confidentiality is assured.
- The nurses were informed that they have the right to withdrawal from the study at any time.

Statistical analysis:

Obtained data were presented as mean± SD, ranges, numbers and ratios. Results were analyzed using paired t-test for inter-group comparisons, Wilcoxon ranked test for unrelated data (Z-test) for comparison versus control group and Chi-square test (X2 test) for comparisons of percentages and numbers. Statistical analysis was conducted using the (SPSS) Statistical Package for Social Services (Version 15, 2006) for Windows statistical package. P value <0.05 was considered statistically significant.

Results:

This table **(1)** show that, 50% of the head nurses, their age were 35 years or more, the mean age of them 30.2±7.16 year. While, 29.1% of the staff nurses, their age ranged between 30 - < 35 years, the mean age of them 31.8±6.34 year. As regard to gender, 81.8 % of head nurses were female, while 55.2% of the staff nurses were female. Regarding marital status, 77.3 % of the head nurses were married, while 65.1% of staff nurses were married. In relation to the qualification, 59.1% of head nurses had higher education, while 47.7% of staff nurses had Diploma of technical nursing institute. Related years of experience, 45.5% o of the head nurses their years of experience ranged between 15 - 25 years, with mean16.4±3.91years, while 66.3% of the staff nurses their years of experience ranged between 5<15 years, with mean 14.1±4.17 years.

This table **(2)** show that, there was a marked improvement in knowledge regarding lean strategies for study subjects post implementation of workshop with highly statistically significant difference at (P= < 0.01) between pre and post implementation of workshop.

This graph **(1)** shows that, 22.70% of study subjects had good level of total knowledge at pre implementation of program. While, 59.1% of them had good level of total knowledge at post implementation of workshop. Also, 31,80 % of study subjects had poor knowledge pre -program comparing to 9,1% of them post-program.

This table **(3)** show that, there was a marked improvement in time (min) of all medication administration items by staff nurses post implementation of workshop with highly statistically significant difference at (P= < 0.001) and statistically significant difference at (P= < 0.05) between pre and post & post 3 months implementation of workshop.

Table **(4)** shows that, there was a marked improvement in staff nurses quality of care during medication administration post implementation of workshop with highly statistically significant difference at (P= < 0.01) between pre and post & post 3 months implementation of workshop.

This graph **(2)** shows that, 18.60% of staff nurses had high level of total quality of care at pre implementation of workshop. While, 63.90% of them had high level of quality of care at post implementation of workshop. Meanwhile, 58.1% of them had high level of quality of care at post 3 months of implementation of workshop.

This table **(5)** show that, there was a marked decrease in frequencies exposure to occupational hazards in all its items during medication administration of staff nurses post implementation of workshop with highly statistically significant difference at (P= < 0.01) between pre and post & post 3 months implementation of workshop.

This graph **(3)** shows that, 65.7% of staff nurses had high level of total occupational hazard at pre implementation of workshop compared to 18% of them had high level of hazards post program and 25% of them had high level of hazards post 3 months of implementation. While, 19,60% of study subjects had low level of occupational hazard at pre-program and 70.3% of them had low level of occupational hazard at post implementation of workshop. Meanwhile, 62.2% of them had low level of occupational hazard at post 3 months of implementation of workshop.

Table **(6)** show that, there was a highly significant negative correlation between quality of

Environmental and occupational safety of the staff nurses and occupational hazards.

Table (7) shows that, 90٪ of participants reported that, program objectives were clear, while 95.2 ٪ of them perceived the program time as adequate. 90.5٪ of them perceived the program time schedule as suitable while 85.7٪ of them perceived the educational climate as comfortable. 100٪ of them reported that, teaching methods were clear& effective while 92٪ of them found clear content.89٪ of them found a chance to apply the new knowledge.

Table (1): Distribution of Head Nurses and staff nurses regarding their demographic characteristics.

Demographic Characteristics	Head Nurses N= 22		Staff Nurses N=172	
Age	**No**	**%**	**No**	**%**
20 - <25	3	13.6	40	23.2
25 - <30	2	9.1	38	22.1
30 - < 35	6	27.3	50	29.1
35 or more	11	50	44	25.6
$\bar{x}$S.D	**30.2±7.16**		**31.8±6.34**	
Gender				
Male	4	18.2	77	44.8
Female	18	81.8	95	55.2
Marital Status				
Married	17	77.3	112	65.1
Not Married	5	22.7	60	34.9
Qualification				
Diploma of secondary technical school	0	0	28	16.3
Diploma of technical nursing institute	0	0	82	47.7
Bachelor of science in nursing	9	40.9	50	29.1
Higher education	13	59.1	12	6.9
Years of Experience				
5<15 years	7	31.8	114	66.3
15 - 25 years	10	45.5	30	17.4
>25 years	5	22.7	28	16.3
$\bar{x}$S.D	**16.4±3.91**		**14.1±4.17**	

Table (2): Comparison between mean scores' knowledge of the study subjects regarding lean strategies at pre and post workshop.

Lean knowledge Items	Mean Pre	Mean Post	T paired test	P. value
Concept of lean management	0.95	1.71	5.716	.004**
Aims of lean	1.21	2.41	4.681	.007**
Strategies of lean	2.45	3.36	9.614	.002**
Obstacles of lean management	1.18	2.70	7.008	.002**
Types of lean	1.32	1.87	4.012	.002**
Principles of lean	0.99	1.69	5.974	.003**
Lean process	1.07	1.83	4.37	.002**
Total knowledge	9.68	15.79	12.56	.001**

(**) Highly statistically significant at p<0.001

Graph 1: percentage distribution of study subjects` total knowledge.

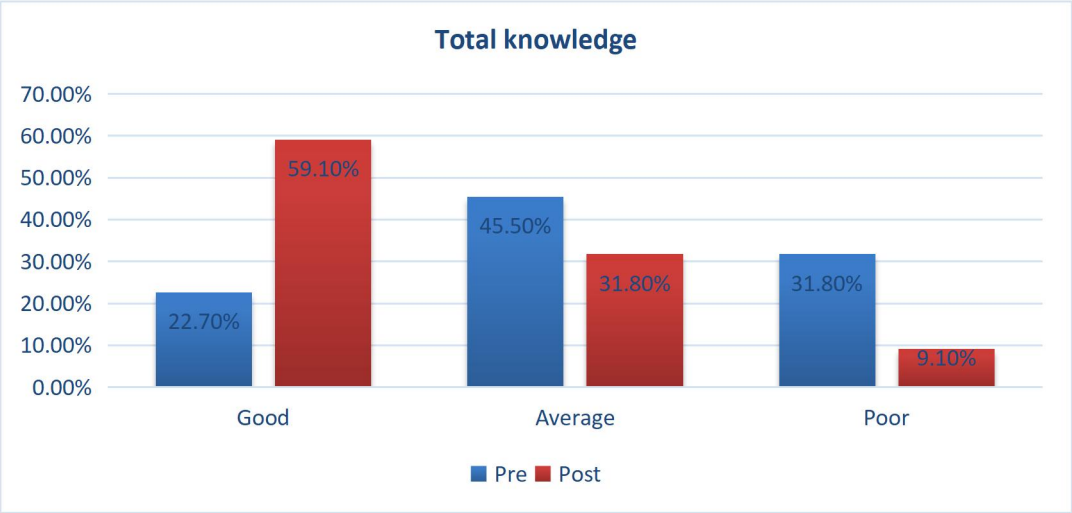

Table (3): Comparison between mean time (min) of medication administration of staff nurses at pre, post & post 3 Months workshop (N= 172).

Medication Administration Items	Mean time						Friedman test	P. value
	Pre		Post		3 months post			
	Mean	S.D	Mean	S.D	Mean	S.D		
Check the accuracy of the medication order.	12.75	2.55	6.58	1.05	7.22	1.47	6.314	.004**
Perform the ten rights: the right patient, the right medication (drug), the right dose, the right route, the right time, the right documentation…etc.	5.58	1.52	4.21	0.80	4.83	0.93	7.089	.002**
Perform hand hygiene. (before)	3.8	1.11	2.0	0.3	2.4	0.41	5.021	.006**
The label on the medication must be checked for name, dose, and route, and compared with the MAR	4.0	0.5	3.0	0.30	3.0	0.0	4.763	.009**
Position patient appropriately safely for medication administration.	2.72	1.0	2.10	0.97	2.93	0.67	5.411	.008**
Complete post assessment and/or vital signs	4.3	0.7	3.47	1.24	4.0	0.19	7.316	.001**
Sign MAR; place in the appropriate chart.	2.7	0.3	2.0	0.1	2.2	0.0	3.504	.011*
Perform hand hygiene after	3.3	0.2	2.5	0.41	2.6	0.33	3.818	.016*

(*) Statistically significant at p<0.05 (**) Highly statistically significant at p<0.001

Table (4): Comparison between mean scores pre, post & post 3 Months workshop for staff nurses regarding quality of care regarding medication administration (N= 172).

Quality of care during medication administration	Mean scores			Friedman test	P. value
	Pre	Post	3 months post		
Patients taken medication at the time.	1.45	2.86	2.61	4.546	.008**
No combination between medications.	1.78	3.0	3.0	3.698	.009**
Medications are given as prescribed.	2.11	2.94	2.87	7.980	.001**
The nurse is very welcoming with the patient during medications administration.	1.30	2.57	2.43	6.117	.002**
Nurse given patient health education.	1.83	2.76	2.83	5.072	.005**
Extent satisfaction of patient about care.	1.42	2.81	2.69	5.976	.006**
Frequency of errors during administration of medication	2.36	1.55	1.67	6.351	.004**
Total	**8.49**	**16.72**	**14.91**	**10.671**	**.000****

(**) Highly statistically significant at p<0.001

Graph 2: percentage distribution of staff nurses regarding Total quality of care (N=172).

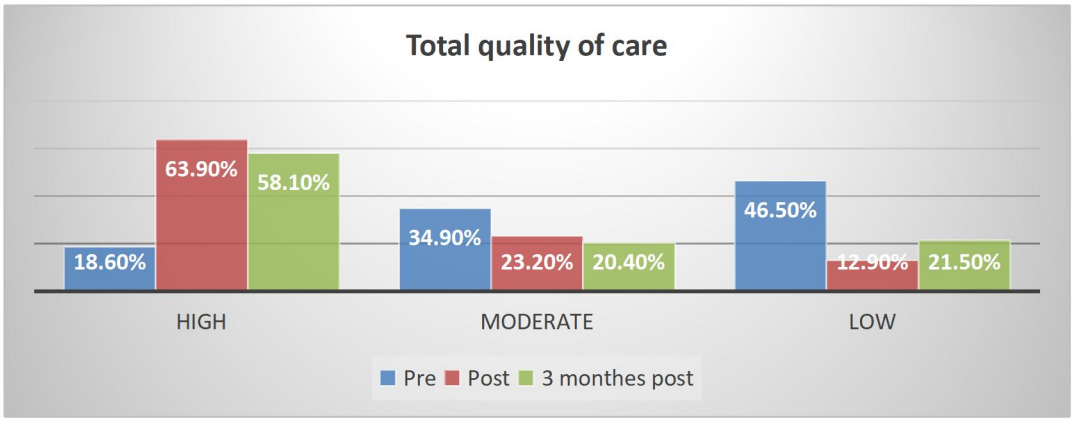

Table (5): Comparison between frequencies exposure of staff nurses to occupational hazards during medication administration pre, post & post 3 Months workshop (N= 172).

Hazards	Frequencies			Friedman test	P. value
	Pre	Post	post 3 months		
Sharp related injuries	58.1%	38.9%	34.3%	13.086	.001**
Infection from patient	46.5%	29.1%	20.3%	16.943	.000**
Cuts and wound	52.3%	34.9%	38.9%	14.258	.001**
Blood borne disease	38.9%	11.6%	19.1%	10.357	.006**
Direct contact with contaminated blood	74.4%	58.1%	59.9%	12.654	.004**
Exposure to high irritant drug	40.7%	17.4%	22.7%	17.951	.000**
Allergy from latex exposure	29.1%	20.3%	20.9%	9.684	.009**
Allergy from medication exposure	40.1%	17.4%	18.02%	11.429	.004**
Stress due to overload	87.2%	52.3%	68.02%	19.753	.000**
Physical and Verbal abuse during drug administration	40.7%	16.9%	20.9%	13.446	.002**

(**) Highly statistically significant at p<0.001

Graph 3: percentage distribution of staff nurses regarding total occupational hazard (N=172).

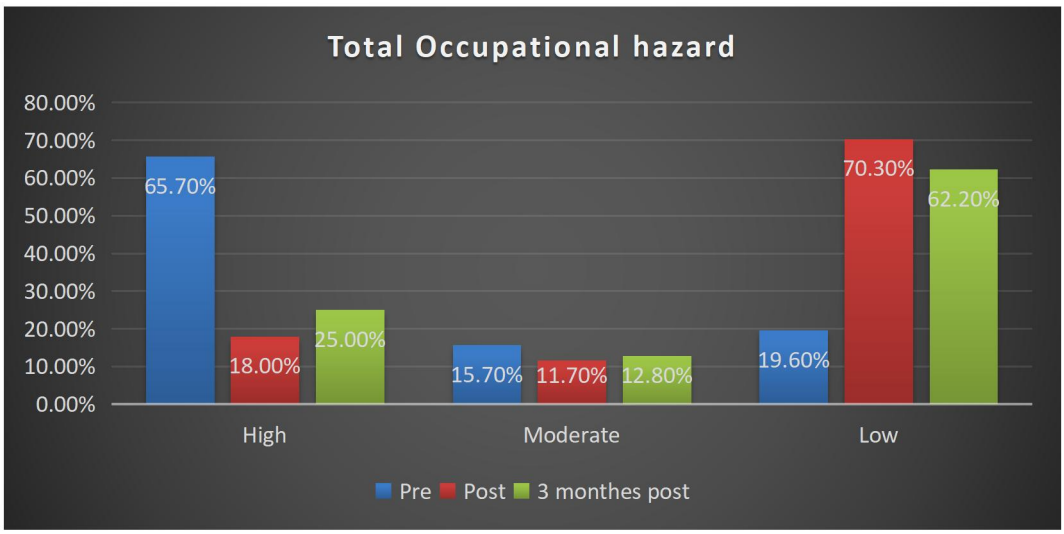

Figure (4): Value stream map before lean strategies training program.

Sequence and time consumed by the staff nurses performing medication administration.

- Total time the nurses consumed performing medication administration =83 minutes
- Total time of value-add tasks= 44 minutes,
- Total time of non-value- add tasks = 39 minutes.

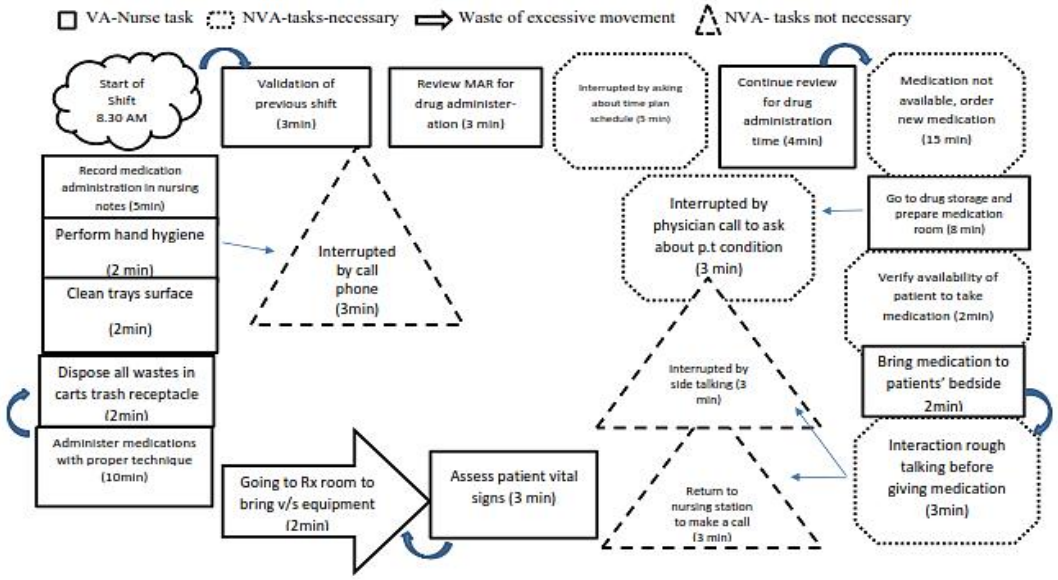

Figure (5): Value stream map after three months of lean strategies training program.

Sequence and time consumed by the staff nurse performing medication administration

- Total time the nurses consumed performing medication administration =62 minutes
- Total time of value-add tasks= 37 minutes,
- Total time of non-value- add tasks = 25minutes.

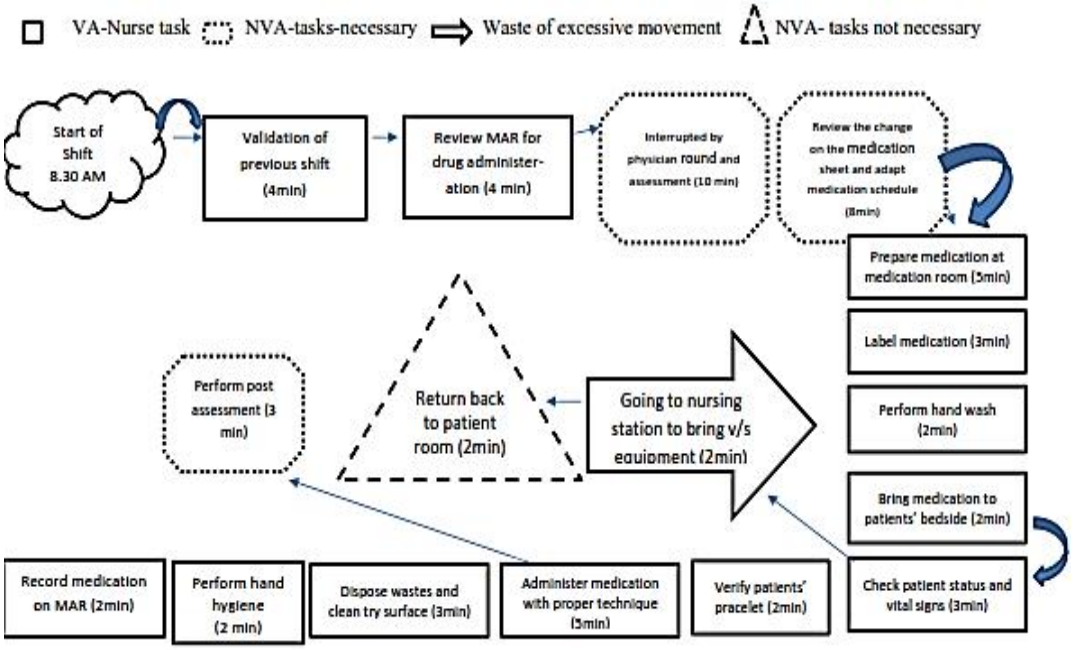

Table 6: Correlation between qualities of care and occupational hazard of nurses.

Items	Quality of Environmental and occupational safety
Occupational hazards	r. - 0.846 P. value .000**

(**) Highly statistically significant at p<0.001

Table 7: The Study Subjects' Reactions of Lean Strategies training program

Items	٪
1- Objectives of the training program	
Clear	90
Not clear	10
2- Time allotted to the program	
Adequate	95.2
Not adequate	4.8
3- Program time schedule	
Suitable	90.5
Not suitable	9.5
4- Contents of the program	
a- Adequate	95
Not adequate	5
b- Suggestions to be more adequate:	-
5- The program added new information	
Yes	100
No	-
6- The educational climate	
a- Comfortable	85.7
Not comfortable	14.3
b- Suggestions to be more comfortable:	
-Allowing more comfortable chairs and better lighting	
7- Teaching methods	
Clear	100
Not clear	-
8- Teaching methods	
a- Lecture discussion	
Effective	100
Not effective	-
b- Brain storming	
Effective	100
Not effective	-
9- **Presentation of the program content**	
Interesting	92
Not interesting	8
10- **Chances for application of gained knowledge from the Program**	
Yes	89
No	11
11- **Suggestions for the program to achieve success**	
- Development of frequent training programs.	

Discussion:

In healthcare, lean strategies training program, as in-service program, creates a condition that improve healthcare services with value-add activities, through applying lean thinking which help in reducing medication time and errors, wastes and hazards to move toward performance improvement that required to support hospital outcomes (Bercaw,2013). So, this study was conducted to investigate the impact of lean strategies utilization training program on quality of environmental and occupational safety.

The results of the present study illustrate that there was a marked improvement in study subjects knowledge regarding lean strategies post implementation of program with highly statistically significant difference at (P= < 0.01)

between pre and post implementation of program. This , may be due to knowledge acquisition becomes especially meaningful when theoretical concepts are applied in real or quasi-real contexts to consolidate learning. This is consistent with Carvalho et al. (2013) who mentioned that, the possibility of experiencing lean tool helps to increase the knowledge and skills levels regarding its main aspects and scope implementation. In accordance Boswihi (2018) illustrated the importance of training and its effective impact on improving knowledge, skills, and attitudes of the participants, as well as the care process.

The findings of the present study indicated that, there was a marked improvement in time of medication administration post program implementation with statistically significant difference at (P= < 0.05) between pre and post and post 3 months implementation of program of nurses to carryout medication administration with improvement in value-add activities and reducing non-value-add activities such as defect, over processing, waiting, motion wastes. This may be attributed to the value techniques allowed us to identify these sources of waste and make recommendations towards reducing waste in the system which will in turn improve patient care. Lean is designed to push team members to think and learn and grows, as the nurse learn, the right process of care will produce the right result, then continuous improvement can occur only after a process is stable and standardized.

By the same token, Al Anwer (2018) who provide a proposed improvement in pharmaceutical process by reducing total amount of lead time and reduce the time of non-value added activities. Also, Rexhepi and Sherstha (2011) stated that, it is important to increase the awareness of nurses on the concept of waste, as well as on the ways identify and reduce waste. Further, Nesensohn et al., (2012) pointed out that, tasks that can be considered as value-added in one area can be considered as waste in another, therefore, clear definition of non-value-add activities is needed, so the staff can recognize them as waste. Likewise, Okpale (2014) reported that, to identify and subsequently eliminate waste, it is pertinent to have a complete understanding of waste and where it exists, with this manufacturing concept, organizations enjoy the benefit of continuous improvement.

The finding of the present study reveal that, there was a marked improvement in quality of care during medication administration of nurses post program implementation with highly statistically significant difference at (P= < 0.01) between pre and post and post 3 months implementation of workshop. This may be due to that, healthcare staff who are undertaken to lean training programs acquire and maintain the main key for clinical competencies. This finding goes in the same line with Ching et al., (2013) who mentioned that, lean process improvements coupled with direct observation can contribute to substantial decreases in errors in nursing medication administration. Van de Plas et al., (2017) in a study employed Lean Six Sigma methodology to reduce medication administration errors, resulted in a reduction of errors by 50 percent. Green and Valentini (2015) who revealed a reduction in medication process after application of value stream map of current process, identified causes of delay, then developed changes to improve process flow such as developing an appropriate dispensing schedule, measure to reduce interruptions. Furthermore, Trakulsunti et al. (2019) stated that, healthcare sectors can benefit from lean principles to improve medication processes, quality of care, and patient safety.

In addition Timmons et al., (2014) studied the impact of lean methodology in medication processes in an emergency setting and elaborated that implementing lean concepts as VSM in the medication preparation process had a positive effect on efficiency and drug cost. Moreover, Critchley et al., (2015) found that a community hospital's resounding success using Lean methodology to improve medication administration safely with process changes designed by engaged nurses and leaders with the knowledge and skill to effect improvements. Also, El Liethy (2015), and Laureani et al., (2013) found medication errors in form of wrong dose, wrong name and concluded that administration of medication in wrong time can be related to failing to administer drug or being

carless due to heavy workload, poor staffing and being distracted.

The result of the present study indicate that there was a marked decrease in frequencies exposure to occupational hazards during medication administration of nurses post implementation of program with highly statistically significant difference at (P= < 0.01) between pre and post and post 3 months implementation of workshop. This result may be due to top management support, talk and respect the staff opinion in the organization of their work environment and asking them to explore what is the most appropriate for them to work easily, remove overcrowding and unnecessary equipment or objects from the work environment. This is in the same line with Poksinska (2010), who found that, nurses are experts in their work areas and their involvement, professional knowledge, experience, and skills are crucial in any effort to improve a health care organization, making it vital that the health care staff be involved in and drive the Lean activity. Also, added that, the successful transformation to Lean in health care is dependent upon the involvement of those doing the work and the understanding and application of Lean principles and techniques within the staff. Also, Critchley et al., (2015) found that a community hospital's resounding success using Lean methodology to improve medication administration safely with process changes designed by engaged nurses and leaders with the knowledge and skill to effect improvements. In addition, Van de Plas et al., (2017) employed Lean methodology to reduce medication administration errors. This resulted in a reduction of errors by 50 percent and therefore an overall decrease in the potential risk of harm.

Sakouhi and Nadeau (2016) in their study of integration of occupational health and safety into Lean Manufacturing, to find the effect of improvements achieved by applying Lean principles on occupational health safety, revealed a strong association. According to Jones et al., (2006), confused responsibilities and unnecessary and extra work result in great chance of errors that undermines quality and threaten safety. Also, Haron et al., (2017), Graban & Swartz (2018), Teich (2013), pointed out that waste of motion affects the performance of the staff in healthcare; it leads to delay in the care process as well as to errors. Additionally, they added that unnecessary motion does not add value in a process flow. Integration of occupational health and safety into Lean Manufacturing.

The result of the present study shows that, there was a highly significant negative correlation between total quality of environmental and occupational care and total occupational hazards. After assessing the study setting (El-Mansoura University Hospital.) personal and environment, it was noticed that they are in need of improvement in quality and environmental safety which can be done through implementing lean strategies by providing a training program to the head nurses and nurses. In the same context Persoon et al., (2016) concluded that the Health Foundation believes that training can be an effective lever for improving the quality of healthcare. Yet education and training initiatives are not always prioritized by policymakers or practitioners. While healthcare organizations are initiating a number of strategies to improve care and respond to changing regulatory and policy requirements, many clinicians practicing in them have not received training on quality and safety as a part of their formal education (Sanders, 2014).

By the same Bashir et al., (2011) concluded that using lean tools may be used to support safety programs in industrialized housing manufacturers by increasing safe behavior and reducing injury rates, by increasing the efficiency of communication through the project level. In addition Anvari et al., (2011) indicated that all the different levels of an organization need to put forth their best efforts on a day-to-day basis and work together toward achieving improved performance and reducing waste, thus productivity, quality and safety will be improved effectively. Moreover, Enshassi and Abu Zaiter (2014) using lean construction tools, reducing waste and increasing efficiency, often reduce the probability of incurring an accident or coming in contact with hazardous materials. In addition Wu (2019) indicated that one of the main goals of the look ahead process is to shape the work flow sequence and rate. In terms of pre-project planning for safety, this allows to establish more reliable project-specific safety resources

for a given time period during a project and thus staff for safety accordingly.

Conclusion:

- There was an improvement in study subjects` knowledge regarding lean strategies post-program compared to pre-program.
- There was a marked decrease in time and frequencies exposure to occupational hazards during medication administration post-program while,
- There was a marked increase in quality of care during medication administration post implementation of the program.

Recommendations:

Based on the findings of the current study, the following recommendations are suggested:

- Improve the organizational readiness for lean strategies implementation through: introduce lean approach in the healthcare settings plans, as well as vision, and enhance leadership behaviors, abilities and commitment to lean principles and encourage staff contributions to continuous improvement.
- Continuous training programs for application of lean strategy with other aspects of patient care.
- Orientation program for all new nurses and in- services training program for experienced nurses about Lean Six Sigma Redesign of a Process for Healthcare.

Recommendations for further research:

- Effect of lean leadership training program on head nurses` performance and patient satisfaction.
- Utilization of lean tools to reduce costs and patient waiting time.

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