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IMPACT OF LEAN MANAGEMENT EDUCATIONAL PROGRAM FOR NURSES ON WASTE REDUCTION DURING WORK

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Abstract

Background: healthcare organizations use a variety of quality strategies to reduce costs and improve quality while increasing effectiveness to be competitive in the healthcare market. Lean management is one quality improvement method that focuses on the customer Aim: to examine the impact of lean management educational program for nurses on waste reduction during work. **Methods:** A quasi-experimental design with one group pretest-posttest was utilized to achieve the aim of the current study this study was conducted at King Khalid Hospital, Najran Saudi Arabia ,on a convenient sample of all nurses who are working in the previously mentioned setting and their number were (50).Three tools were utilized as follows:(1) Personal data sheet which includes personal data about nurses, (2) Knowledge questionnaire about lean management (241items). And (3) Wastes Identification Practices Observational Checklist (42 items). **Results:** There were statistically significant increase in staff nurses' total knowledge of lean management mean scores (F=42.07, P=0.000) immediately post-training and three months later than pre-program as well as statistically significant differences in all dimensions of waste reduction practices mean scores (F=819.165, P=0.000*) immediately post-program and three months later than pre-program. Also, the current study findings revealed there was statistically significant negative correlation between nurses' lean management knowledge and their waste reduction respectively (r=0.88, P=0.000). **Conclusion:** The educational program had positive effects for lean management of nurses on waste reduction during work. Recommendations: Implement mandatory educational and training programs about lean management for nursing staff to raising their awareness regarding application of lean methods.

Keywords: Lean Management, Waste Reduction.

1. INTRODUCTION

Healthcare is a field where effectiveness and efficiency are crucial because any deviation could cause a crisis. Because of this, healthcare organizations use a variety of quality strategies to reduce costs and improve quality while increasing effectiveness to be competitive in the healthcare market. Lean management is one quality improvement method that focuses on the customer [1].

Lean management is defined as "the endless transformation of waste into value from the customer's perspective". Lean is both a management and a methodology, utilizing its tools or techniques, aimed at improving quality and reducing waste. In order to do this management, need to take a systems approach to how they view their organizations.

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These systems consist of processes that deliver outputs products and services to internal and external customers [2].

Lean management principles are 1- identifying the value stream (all value-added steps across departmental boundaries), eliminating steps that do not create value 2-make value flow continuously(eliminate causes of delay, such quality problems)3- let customers pull value (avoid pushing work onto the next process or department; let work and supplies be pulled as needed)4- pursue perfection (through continuous process improvement [3].

Waste reduction is a method for eliminating any expense or effort that is expended but does not transform raw materials into an item the customer is willing to pay for. By optimizing process steps and eliminating waste, only true value is added at each phase of production Waste management practice is a set of operating philosophies and methods that help create maximum value for patients by reducing waste and waits. It emphasizes the consideration of the customer's needs, employee involvement and continuous improvement [4].

Waste reduction practices must be assessed and observed among the hospital staff to find out if the resources are used efficiently and effectively without any waste .if those practices are not used by the staff so waste in resources will be huge and the use of supplies and equipment will exceed the actual performance , for example if the nurse uses too many syringes in withdrawing a blood sample for a single patient and repeat this action with each patient at the end of the shift one nurse will consume a huge amount of syringes so this is a great waste. [5]

By using lean management techniques wastes can be managed in hospital and will positively affect the performance, such as ensuring the patient and employee satisfaction with the right processes, increasing the number of patients served per unit time, performing more jobs with less inventory, reducing losses and cost, and ensuring sustainability and other related issues [6].

Many studies reported successful lean applications in health care which the most common areas of improvement included time-savings, timeliness of service, cost reductions or productivity enhancements, and several quality aspects including reduction in errors or mistakes, improved staff and patient satisfaction, and reduced mortality [7]. An obvious application of lean management in healthcare lies in eliminating waiting times, repeat visits, errors, interruptions and inappropriate procedures [8]

Application the lean management can achieve positive results (such as high practitioner satisfaction and improved quality indicators) with a value of practices such as team training, process management, continuous improvement and delegation of responsibilities [9].

As the investigator observed a lot of wastes in the selected study unit such as-excess motion (people or equipment walking or moving more than necessary to perform the process) ,underutilized people (not using the full abilities of people/employees), waiting times for(equipment and materials), inventory (overstocked drugs that expire, under

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stocked surgical supplies that lead to delays while staff search for them and disorganization),and workflow interruptions that delay patient care and wastes staff nurses time and effort. Any waste will effect on patient care so nursing staff need to be aware about the wastes that occur in the hospital also the way to solve this harmful problem. By using lean management nursing staff could deal with the waste problem and work more efficiently and effectively.

All these wastes increase the health care cost, decrease patient safety, satisfaction, decrease quality of care and staff satisfaction. Also increase turnover and absenteeism among staff and harm the hospital's reputation. So, this study under the title of effect of lean management training program on waste management practices among nursing staff could help improving patient outcome, satisfaction and safety also enhance staff satisfaction and empowerment and decrease the cost of health care, improve productivity and hospital reputation.

2. METHODS

2.1 Aim

The current study aimed to examine the impact of lean management educational program for nurses on waste reduction during work

Hypotheses of study

Based on literature and theoretical framework the following hypotheses will guide the study:

H1: There will be difference in knowledge test scores of nurses about lean management after the program implementation and three months later compared to before.

H2: There will be difference in test scores of nurse's waste reduction after the program implementation and three months later compared to before.

2.2 Design

Quasi experimental research (one group pretest/posttest) design: Quasi experimental research design is an empirical study used to estimate the causal impact of an intervention on its target population without randomization and control [10].

2.3 Setting

This study was conducted at King Khalid Hospital, Najran Saudi Arabia which include 330 beds to provide free care services. The study setting included two specialized intensive care units within the hospital: Adult Medical and Surgical Intensive Care Unit (ICU): This unit is located in the main hospital building and provides critical care services for adult medical and surgical patients with 38 bed capacity. Cardiac Intensive Care Unit (Cardiac ICU) is located on the second floor of Prince Sultan Building. This specialized unit provides intensive and specialized cardiac care for patients with acute and chronic cardiovascular conditions with 10 bed capacity. The study conducted in previously mentioned ICUs

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2.4 Participants

A convenient sample of nurses who are working in the previously mentioned setting will constitute the study sample, their number (50).

2.5 Data Collection Tools

Data of the current study was collected using these three tools:

First tool: Personal data sheet developed by the researcher which includes personal data about the participants, as (age, level of education, gender, years of experience in nursing, years of experience in hospital, type of unit they are working at and the previous training programs that were received about lean management

Second tool: Lean Management Knowledge Questionnaire was used to assess the nurse's knowledge about lean management concept. It was developed by 11] and modified by a researcher. It contains four dimensions with (24) questions divided into (19) multiple choice MCQ about "techniques of lean management, (6 questions)," principles of lean management (6 questions) and types of wastes in health care" (7 questions). And other (5) true and false questions for lean management and waste management concepts. The value of each question was granted one point for the correct answer, and zero for the incorrect answer. The total scores for all questions were 24, if the final score were (<60%) indicated (low knowledge about lean management concept), if the final score were (60%-75%) indicated (moderate knowledge about lean management concept), and if the final score were more (>75%) indicated high knowledge about lean management concept)..

Third tool: Wastes Identification Practices Observational Checklist. It was used to assess the most frequent waste occurring among nursing staff at the selected units The tool was developed by the researcher based on a review of the relevant literature and previous studies [19,22,25,26]. It consisted of eight dimensions to collect data that relevant to the study and divided into (43) items as follows: over production (7 items), waiting (5 items), excess motion (4 items), excessive transportation (2items), over processing (2 items), inventory (4 items), underutilized staff (6 items) and interruptions (13 items). The answer was a 3-point Likert scale on the waste management practices 3 (always) ,2 (sometimes) and 1(never), scoring represented varying levels waste management practices. The total scores were expressed as percentage, cut point was 50%. if the final score was indicated low waste, if the final score was (50% -75%) indicated moderate waste and if the final score more than 75% indicated high waste

Content validity was checked by a panel of three experts from the nursing administration department. Each of the experts were asked to examine the data collection tools for their content, coverage, clarity, wording, length, format and the overall appearance of the tool. In addition, Cronbach, s Alph test was done for the study. Tools the calculated reliability was (0.90) for lean management knowledge questionnaire, as to regarding waste management practices observational checklist the calculated reliability was (0.82).

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2.6 Procedure

The study was conducted in six phases:

I. **Assessment phase:** Assessing the knowledge level of nurses about lean management, assessing waste level during work, and assessing if nurses received any courses about lean management or not.

II. **Planning phase:** Based on the results of the initial assessment of nurses' knowledge that was analyzed, the researcher designed the educational program including seven sessions.

III. **Validation phase:** The training program was tested, revised by group of three experts, professors from the faculty of nursing, Cairo University

IV. **Communication and approval phase:** After testing the validity of the suggested program, it was communicated to the director of King Khalid Hospital, Najran Saudi Arabia), then taking an approval for implementing the preparation program for nurses in their workplace.

V. **Implementation Phase** After designing and reviewing the training program, it was implemented for nursing staff. The lean management training program was carried out in four weeks. The program was supposed to be 14 hours classrooms teaching and practice. The duration of each session was two hours, with a total number of seven sessions, offered in three sessions per week. Some sessions were repeated more than one time during program administration because most of the participants were staff nurses that was difficult to gather them at one time. The duration of the training sessions was 30 minutes for each session and at the beginning of the first session an orientation to the nursing staff about program purpose, objectives, sessions contents, time and place of each session. Sessions were held in lecture room, and others were done at staff working unit. Each session started with objectives; outlines and at the end of each session the study participants asked questions and an overview of the new topics were discussed. The program sessions were on the morning shift and on the afternoon shift. Feedback was given continuously after each session to ensure understanding.

VI. **Evaluation and Follow-up phase:** In this phase the researcher evaluated the immediate impact of the training program, the same previous knowledge questionnaire and observational check list were used. To measure the nursing staff knowledge retention and waste management practices follow up was conducted three months after program implementation with the same previously used tools to assess nursing staff knowledge about lean management and waste management practices

2.7 Statistical data analysis

data was scored, tabulated and analyzed by (SPSS) version 20. Data was analyzed using descriptive statistics in the form of frequency distributions, percentage mean and stander deviation, T. test, Pearson's correlation test and inferential statistics in the form of P value (≤0.05). The appropriate statistical tests were used like analysis of variance (ANOVA) test

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to show relationship between more than two variables, t- test to compare between different periods of assessment also the Chi square was utilized

3. RESULTS

Table 1 shows that showed that the highest percentage (94%) of the study sample was female while (6%) of them were male. The highest percentage (48%) of the study sample were in age group ranged between (30-<40) years while (28%) of them were in age group (20-<30). The above table illustrated that (90%) of the study samples had bachelor's degree in nursing while (6 %) had master's degree in nursing. It's clear from the above table that the highest percentage (42%) of the study sample had years of experience ranged from (5-<10) while the lower percentage (12%) of them had years of experience (15-<20) years. The same table illustrated that all the study samples (100%) didn't attend previous lean management training programs.

Table 2 shows that showed that there was statistically significant increase in nursing staff knowledge test scores regarding lean management knowledge dimensions immediately post program and slightly decreased three months later compared to preprogram which is reflected in total mean scores respectively (6.44±2.29, 20.18±1.27,16.82±2.46), (F=595.630, P=0.000). The same table showed that (Techniques of lean management) dimension had improved immediately post program (5.28±1.9) and three months later (4.36±2.67) compared to preprogram (1.22±2.41) (F=42.07, P=0.000)

Table 3 showed the comparison between levels of nursing staff total knowledge during different periods of assessment. It is clear that there was a statistically significant difference in total knowledge during different periods of assessment. As showed (100%) of nursing staff scored low (<60%) preprogram, a marked improvement was seen immediately post program and three months later as (86.7%) of nursing staff scored high (>75%) immediately post program, while (52 %) of them had moderate score (60%-75%) three months post program. (χ^2=106.2, p= 0.000*)

Table 4 indicated that there was a statistically significant difference in mean scores of all dimension of waste reduction practices during different periods of assessment preprogram, immediately post program and three months later which was reflected on the total mean score respectively (113.78, ±6.93, 66.48,± 6.22, 65.70±7.22) (F=819.165, P=0.000*).

Table 5 illustrates that there was a statistically significant difference in total waste reduction practices levels during different periods of assessment. As shown (100%) of nursing staff scored (>75%) high preprogram, a marked improvement was seen immediately post program and three months later as (56%) of nursing staff scored moderate (50-74%) immediately post program. The score improved less in three months later as (54%) of them scored (50-75%) than immediate post program. χ^2=150.1, p= 0.000*)

Table 6 showed that there was no statistically significant correlation between nurses' lean management knowledge and their Demographic data respectively (r=0.43, P=0.66)

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Table 7 shows that showed that there was statistically significant negative correlation between nurses' lean management knowledge and their waste reduction respectively (r= -0.88, P=0.000)

Table 1: Frequency Distribution of nurses According to Personal data (n=50)

Demographic data	No.	%
Gender		
Male	3	6.0
Female	47	94.0
Age		
20-<30	14	28.0
30-<40	24	48.0
40+	12	24.0
Education		
Nursing diploma	2	4.0
Bachelor's degree	45	90.0
Master's degree	3	6.0
Experience		
<5 years	10	20.0
5–<10 years	21	42.0
10–<15 years	13	26.0
≥15 years	6	12.0
Training		
Yes	0	0
No	50	100.0

Table 2: Comparison of total mean scores of nurse lean management knowledge dimensions during different periods of assessment (Preprogram, immediately post program and three months later) (n=50)

Items	Pre		Post		Follow up		ANOVA	P
	mean	Sd	mean	sd	Mean	sd		
Techniques of Lean Management	1.22	2.41	5.28	1.9	4.36	2.67	42.07	.000*
Principles of Lean Management	1.86	2.78	5.38	1.57	4.8	2	46.78	.000*
Types of waste in health care	1.68	2.96	5.88	2.42	4.56	3.32	31.37	.000*
Lean and waste reduction concepts	1.68	2.35	3.64	2.18	3.1	2.39	10.66	.000*
Total	6.44	2.29	20.18	1.27	16.82	2.46	595.630	.000*

Table 3: Frequency distribution of total lean management knowledge levels among nurses during different periods of assessment (pre, immediately post program and three months later) (n=50)

Level	Pre		Post		Follow up		X2	P
	No.	%	No.	%	No.	%		
Low knowledge (<60%)	50	100.0	0	0.0	2	4.0	106.2	0.000*
Moderate knowledge (60%-75%)	0	0.0	2	4.0	26	52.0		
high knowledge (>75%)	0	0.0	48	96.0	22	44.0		

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Table 4: Comparison of the mean scores of nurses' waste reduction during work during different periods of assessment (Pre, immediately post program and three months later) (N=50×3 observation = 150)

Items	Pre		Post		Follow up		ANOVA	P
	Mean	sd	mean	sd	mean	sd		
Overproduction	18.06	2.08	10.64	2.13	10.66	1.99	214.363	.000*
Waiting	13.12	1.59	7.56	1.54	7.20	1.53	228.959	.000*
Excess motion	10.26	1.38	6.04	1.31	5.90	1.18	183.409	.000*
Excessive transportation	5.34	0.72	3.12	0.75	3.30	0.76	137.962	.000*
Over processing	5.38	0.81	3.26	0.80	3.16	0.84	117.766	.000*
Inventory	10.66	1.32	6.36	1.40	6.34	1.24	177.810	.000*
Underutilized staff	16.14	1.95	9.42	1.69	8.98	1.77	246.998	.000*
Intrruptions.	34.82	2.89	20.08	2.61	20.16	2.75	475.347	.000*
Total	113.78	6.93	66.48	6.22	65.70	7.22	819.165	.000*

Table 5: Frequency distribution of total waste reduction work during levels among nurses during different periods of assessment (pre, immediately post program and three months later) (n=50) (N=50×3 observation =150)

Level	Preprogram		Immediately Post program		Three months later		X2	P
	No.	%	No.	%	No.	%		
Low waste (<50%)	0	0.0	22	44.0	23	46.0	150.1	0.000*
Moderate (50-75%)	0	0.0	28	56.0	27	54.0		
High (>75%)	50	100.0	0	0.0	0	0.0		

Table 6: Correlation between Demographic data of samples studied and waste reduction

Demographic data	waste identification	
	R	P
Age	0.01	0.92
Education	-0.20	0.049*
Experience	-0.03	0.83
	T	p
Gender	0.45	0.65

Table 7: Correlation between nurses' total lean management knowledge and total waste reduction during work during periods of assessment (pre, immediately post program and three months later) (n=50)

Wastes reduction	Lean Management Knowledge	
	R	P
Total	-0.88	.000*
1-Overproduction	-0.79	.000*
2-Waiting	-0.83	.000*
3-Exess motion	-0.78	.000*
4-Excessive transportation	-0.71	.000*
5-Over processing	-0.72	.000*
6-Inventory	-0.76	.000*
7-Underutilized staff	-0.82	.000*
8-Intrruptions.	-0.84	.000*

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4. DISCUSSION

The result of the current study revealed that the majority of the study sample were females, The majority of them had bachelor's degree in nursing, these results were in the same line with [1] who find that the majority of the studied nurses were females, in contrast, [13] found that the majority of study sample were male.

In addition, the findings showed that nearly half of the nurses' years of experience ranged from five to ten years. These results agree with [14] reported that half of the study sample had experience ranged between five to less than fifteen years.

Regarding participant age, majority of study sample age ranged from thirty to forty, these results were against with [15] who found that almost fifty percent of the study samples were at the age ranged from twenty to thirty years old.

As regard, the study showed that the participants did not attend previous lean management educational programs. From the researcher point of view this might be possibly because lean management concept is a new concept in health care and did not include in hospital plan. These results were in agreement with [1] who displays that the most studied samples were not trained in lean management before. Conversely, [16] found that thirty percent of the study sample attended educational program about lean management.

The current study revealed that the current study there was high statistically significant difference in mean scores of nursing staff regarding lean management knowledge dimension during different periods of assessment. From the researcher's point of view this improvement in lean management dimensions might be because the lean management concept is new and nurses seek to capture needed data and information about it and apply this information in daily nursing care to decrease their waste and improve nursing care provided in timely, high quality and effectiveness way.

This result agrees with [17] also confirmed that Firstline nurse managers' Lean knowledge improved markedly after an educational program, shifting from a low to a high level. In contrast [18] reported that nurse managers struggled to internalize Lean concepts despite training.

Pertaining to the participants' knowledge levels, The results of the current study revealed that there were high statistically significant differences with marked improvement in nurses' knowledge total mean scores regarding lean management knowledge level immediately post program implementation and three months later compared to before program implementation also all of them had low knowledge mean score before program implementation. The results were supported by [19] who found that there was highly significant improvement in level of knowledge of staff nurses about lean management throughout post and follow up phase.

The current study revealed that there was a statistically significant difference with marked improvement in all dimensions of waste reduction during different periods of assessment immediately post program and three months later compared to pre-program

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implementation. these results consistent with [11] who reported that a statistically significant distinction existed between program phases with marked improvement in all dimensions of waste management practices during different assessment periods immediately post-program and three months later compared to preprogram implementation.

The current findings indicated that there was a statistically significant difference in total waste reduction levels during different periods of assessment. all nurses scored high preprogram, a marked improvement was seen immediately post program and three months later as most of nurses scored moderate immediately post program .and three months later. This result was consistent with [20] showed that Lean thinking in healthcare organizations contributed to risk mitigation, reductions in infection and medication errors, and improvements in patient and staff safety. Also, [21] concluded that less than half of the nursing manager exercise waste management practices before the application of the study then near 80 percent of them improved in using waste management practices

The results of the current study indicated that there is statistically significant difference between nurses' waste reduction and their education. These results were consistent with [22] who stated that staff nurses' education has positive relationship with their ability to apply waste management practices, but on the contrary [23] indicated that no statistically significant association between education between participation in training sessions and the level of knowledge of waste management and application of waste practices.

The present study showed that there was statistically significant negative correlation between nurse's lean management knowledge and their waste reduction immediately post program and three months post program implementation. This consistent with [24] concluded that lean management application in healthcare is progressively demonstrating its capability in dealing with emergency department crowding and patient dissatisfaction by developing a care delivery system with a focus on the individual.

5. CONCLUSION AND RECOMMENDATIONS

In the light of the present study findings, it can be concluded that there was a statistically significant difference in the mean scores of knowledge test regarding lean management among nurses, indicating a marked improvement of their awareness about lean management immediately post-program implementation and three months later compared to pre-program. Additionally, there was a statistically significant difference in nurses mean scores of waste reduction practices post program implementation and three months later compared to pre-program. This indicated that there was positive effect of implementing an educational program about lean management for nurses, equipping them with the knowledge and practices needed to control overall waste in workplace. Moreover, all hypothesis of the study is accepted.

Additionally, hospital administrators should raise nurse managers' awareness regarding importance of lean management concept and its impact on organizational effectiveness and disseminating this culture among staff nurses. Provided nurse managers with equal

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opportunities toward attending educational and training programs, conferences, workshops and online meetings that emphasize lean management and waste reduction practices to enhance organizational performance. Conduct regular and periodic meetings with nursing staff to discuss their complaints and troubles and engage them in organizational decisions and develop committee responsible for discovering different sources of waste and regular follow-up to minimize these wastes and monitor the application of different strategies.

6. DECLARATIONS

6.1 Ethical Considerations

A primary official approval was obtained from the research ethics committee, Faculty of Nursing, Cairo University, to conduct the proposed study then an approval from the director of King Khaled hospital. All participants reported that Participation in the study is voluntary. The ethical considerations include explaining the purpose, nature of the study and stating the possibility to withdraw at any time. To ensure confidentiality for the participants; data will not be accessed by any other party without taking permission of the participants.

6.2 Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

6.3 Competing Interests

The authors declare that they have no competing interests.

6.4 Funding

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