

## ORIGINAL RESEARCH

# Starting the lean journey: The effect of lean awareness on nurses' knowledge and readiness for lean transformation in the hospital

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**Received:** April 19, 2019

**Accepted:** May 6, 2019

**Online Published:** May 21, 2019

**DOI:** 10.5430/jnep.v9n8p108

**URL:** <https://doi.org/10.5430/jnep.v9n8p108>

## ABSTRACT

**Background and objective:** Lean is a form of quality improvement which receiving an increased attention and rapidly becoming the latest approach in healthcare. Lean presents a set of philosophies, principles, and tools for (re)designing hospitals to maximize value and minimize waste, improving performance and care quality. Leading the journey of Lean transformation (LT) in the nursing units is a natural role of nurses. It has been indicated that enhancing nurses' awareness and knowledge about Lean approach is essential for increasing nurses' readiness in order to assume an active role in LT Journey in hospitals. The aim of this study was to determine the effect of lean awareness on nurses' knowledge and readiness for LT at a private hospital.

**Methods:** A quasi-experimental research with one group pre-post-test design was conducted with all nurses (N = 90) who are working in a private hospital, Egypt. Lean Awareness Sessions (LASs) were introduced to nurses as the study intervention. Lean knowledge questionnaire and Organizational Change Recipients' Belief Scale were used for assessing nurses' knowledge and their readiness for LT, respectively.

**Results:** Nurses' knowledge of Lean concept significantly improved after attending LASs compared with pretest knowledge questionnaire ( $p < .001$ ). A strong significant positive correlation increased between overall nurses' knowledge of Lean and their readiness for LT after attending LASs ( $r = 0.697, p < .001$ ). These results prove that the knowledge nurses acquired through LASs increased their readiness in a significant way for LT.

**Conclusion and recommendations:** For a successful transformation towards Lean hospital, significant factors should be considered by hospital and nursing managers such as: training programs, nurses' empowerment, and effective communication. The readiness for Lean should be supported by understanding the necessity for change, having clear and endless leadership direction, and a strong change agent. Future longitudinal study may permit stronger statements regarding the causal relationship between Lean knowledge and readiness and to understand how Lean adoption impacts nurses' outcomes.

**Key Words:** Lean awareness, Readiness to change, Nurses, Lean transformation, Hospital

## 1. INTRODUCTION

In today's world, hospitals face a growing pressure in terms of service quality, patients' safety, efficiency, cost, waiting times, staff morale, and many more.<sup>[1]</sup> To stay competitive

in today's global environment, it is imperative to assure that healthcare organizations provide excellent care and create value by improving quality while eliminating unnecessary costs.<sup>[2]</sup> There are many approaches to quality improvement

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(QI). “Lean”, a form of quality improvement, is receiving increased attention and rapidly becoming the latest approach in healthcare.<sup>[3]</sup>

Lean presents a set of philosophies, principles, and tools/methods for (re)designing hospitals to maximize value and minimize waste, improving performance and quality, reducing costs in work processes, lessen error rates and reduce wait times for patients.<sup>[4]</sup> As patients are the end customers of care, the value must be defined from their perspectives and this is what Lean presents.<sup>[5]</sup>

The primary focus of Lean is to provide value-oriented services that are efficient and prompt in delivery. In the health service, the aspects that the patient’s values include a better, safer, faster, quality and decisive care, according to his/her needs, aiming for the full recovery of his/her well-being.<sup>[6]</sup> In addition, Lean approach seeks to understand the work processes in order to identify and analyze problems and existing waste,<sup>[7]</sup> organizes the most effective and/or efficient processes,<sup>[8]</sup> improves the detection of errors in these processes, providing information for the solution in order to avoid health damage,<sup>[9]</sup> and manages change and problem-solving in a scientific approach.<sup>[10]</sup>

Transformation to Lean to be a natural part of daily work routines is challenging in hospitals.<sup>[11]</sup> It reinforces healthcare providers to revise their current care processes and refocus on their patients and patients’ families’ needs.<sup>[6]</sup> Successful implementation of Lean transformation requires announcing, explaining and preparing healthcare providers for this change and the effect of the impending change, especially in the early stage to become Lean.<sup>[11]</sup>

## 1.1 Conceptual framework

### 1.1.1 Nurses’ knowledge and readiness for lean transformation in hospitals

The current study stands for the conceptualization that adequate knowledge of Lean and increased readiness for Lean are essential elements for Lean adoption and implementation for any hospital that wants to implement Lean as a quality improvement approach.

Certainly, leading a complex Lean transformation of nursing units is a natural role for nurses.<sup>[11]</sup> Lean is based on the assumption that nurses and other healthcare providers working on the “front line” of health services are better able to decide what patients need.<sup>[10]</sup> In this context, the Institute of Medicine (2010) emphasized that hospitals should engage nurses to be full partners, with physicians and other healthcare providers, in leading collaborative improvement efforts and redesigning healthcare.<sup>[12]</sup>

Adoption of Lean processes or concepts on a nursing unit and

in the hospital should be evident to nurses and they should be enabled to lead the diffusion of Lean.<sup>[13]</sup> However, nurses who aspire to be leaders need a robust fund of knowledge and a deep skills portfolio to apply Lean in their organizations. This new knowledge and skills go far beyond the traditional nursing curricula because they span a variety of concepts such as Lean principles, deadly wastes, and Lean tools and techniques.<sup>[11, 14]</sup>

Lean has been applied worldwide based on 5 principles including; specify the value desired by the end customer, identify the value stream (end-to-end journey), create flow, respond to customer pull, pursue and striving for perfection by continuously improving processes. Whereas waste refers to non-value-added activities occurring as a result of the system. Many types of wastes also, have been identified in Lean literature, namely: overproduction, waiting time, transportation, unnecessary motion, inventory, over processing and defective products. While, Lean tools identified as lean building blocks to improve care processes. The most commonly highlighted tools in the literature are; 5S program, Kaizen, Just-in-time (JIT), Fishbone Diagram, Why-Why Analysis, and Deming Cycle.<sup>[2, 5, 6, 11]</sup>

Therefore, increasing capacity for new knowledge through organizational learning are antecedents for any innovation and Lean management. Hence enhancing nurses’ awareness about Lean and related concepts is the first step for increasing nurses’ readiness and adopting an active role in the Lean transformation journey. Another crucial factor for successful Lean transformation is assessing readiness for change toward it. In this regard, Armenakis and colleagues (2007) developed a conceptualization of individual readiness for change that has been adopted by the current study.<sup>[15]</sup> They identified five factors to enhance and measure individual readiness to change namely; discrepancy, appropriateness, efficacy, principal support, and valence.

First, Discrepancy refers to an individual’s belief that there is a need for change. Also, Kotter (2007)<sup>[16]</sup> refers to this as building a sense of urgency, a catalyst for putting individuals into motion. If individuals do not sense urgency, they may not participate in change efforts at all or only give it a token attempt. Second, Appropriateness reflects that individuals must believe that the change is right and proper for the organization. The appropriateness of the change needs to be communicated effectively to all affected individuals. If some individuals hear about the change and some do not, the change will be slowed. Third, Efficacy refers to the individuals’ beliefs that they can contribute to the change. They need to believe they have the knowledge and behaviors necessary to make a difference. It is crucial to provide individuals

with appropriate training and knowledge, so they do feel capable. Fourth, Principal Support, individuals need to see if the organization provides support and leadership for the change. Lastly, Valence, individuals must see what is in the change for them. Valence refers to the appeal of the outcome from the change. The benefit could be extrinsic such as a monetary reward or intrinsic such as more decision-making authority.<sup>[15, 16]</sup>

## 1.2 Significance of the study and problem statement

Knowing the requirements of Lean is a key for starting the transformation in a Lean journey. In other words, the hospitals must measure their healthcare providers' knowledge and readiness for Lean and understand its requirements prior to implementing a Lean transformation process, which could save their time, effort and money.<sup>[17]</sup>

Studies on the implementation of Lean principles in healthcare have been limited and there are few studies that considered the consequences of Lean on healthcare workers' perceptions of Lean.<sup>[18]</sup> Also, there is a lack of in-depth research on Lean readiness. Researchers and practitioners have shown that, despite the benefits that Lean can offer to organizations, there have been a large number of failed implementations of it.<sup>[19]</sup> This failure can be attributed to one single cause, which is a lack of understanding of the key elements of Lean.<sup>[20]</sup>

Internationally, a study done by Joyce et al., (2012) presented how nurses can lead the Lean way in healthcare reform and presented successful cases of nurse-directed Lean initiatives. They concluded that nurses need training on concepts, tools, and skills required for adapting Lean to the patient care environment.<sup>[11]</sup> Another study was done by Boswihi (2017) found that there is a significant positive effect of Lean leadership training program on head nurses' performance and patients' satisfaction.<sup>[21]</sup> In Egypt, El-Sayed et al., (2017) studied factors associated with nurses' readiness for organizational change at a university hospital.<sup>[22]</sup> They recommended that nursing leaders' efforts must be directed toward creating an environment that promotes nurses' readiness for change by providing them with access to the opportunity to learn and grow and create an autonomous work practice. A recent review of Lean in healthcare concluded that research is needed to evaluate how Lean is perceived by healthcare staff and to what extent they are ready to implement it.<sup>[20]</sup> Hence, the current study aimed to fill this knowledge gap.

## 1.3 The context of the study

To the knowledge of the researchers, no study had been conducted to assess nurses' knowledge and readiness for Lean transformation in private hospitals. To address the gap

identified above, the researchers were challenged to examine the effect of introducing learning intervention for nurses at a well-known private hospital (namely, German hospital) at Alexandria, Egypt, in terms of awareness sessions about Lean concept on their knowledge and readiness for Lean transformation. This study was conducted in response to the hospital administrator's need to adopt the Lean approach. The researchers were invited to provide the nurses with knowledge and awareness sessions about Lean and its benefits to the nurses with the belief that nursing staff are the front-line healthcare providers and that any change or innovation should start from them.

The current study focused on a baseline assessment of nurses' knowledge of Lean and identifying their readiness for its implementation as the first phase of Lean transformation journey. Subsequent phases will be conducted in future studies to implement Lean and measure its impact on nurses and hospital outcomes.

It is hoped that this study could contribute to the body of knowledge of Lean. As the findings of this study might provide an insight into the benefits of Lean and could help the hospital's leaders to identify factors that are affecting nurses' readiness in order to improve them. Also, it might provide nurses with knowledge and skills in identifying waste or non-value add steps in the care processes through using Lean tools and replace the waste with value-added activities.<sup>[11]</sup> Also, adding nurses' experiences to the emerging Lean implementation literature provides further evidence of the importance of nurses' readiness as a precursor for healthcare organizational innovation and transformation.

## 1.4 The aim of the study

The aim of this study was to determine the effect of Lean awareness on nurses' knowledge and readiness for lean transformation at a private hospital.

## 1.5 Research hypotheses

The hypotheses of the study were postulated as the following: Hypothesis 1: Nurses' knowledge and readiness for Lean transformation will be significantly increased by their participation in Lean awareness sessions.

Hypothesis 2: There is a significant positive correlation between nurses' knowledge and readiness for Lean transformation in the hospital.

## 2. MATERIAL AND METHODS

### 2.1 Research design and setting

Quasi-Experimental research using a one-group, pre-post-test design was conducted. The private hospital in which the study was conducted (German hospital) is for-profit and is

affiliated to the private health sector, Egypt. It is one of the oldest and well-known private hospitals that provide paid comprehensive healthcare services for all patients including medical, surgical, intensive and emergency, and multispecialty care. It included 75 beds with different units divided into; Pediatric Intensive Care Unit (PICU, n = 6), internal units (medical-surgical, n = 38), dialysis (n = 8), Operation Room (OR, n = 5), Intensive Care Unit (ICU, n = 11), and Emergency Room (ER, n = 7).

## 2.2 Subjects

The subjects of the study comprised all nurses (N = 100) who had been invited and willing to participate in the study. The sample size was calculated using the "Epi info program version 7" and indicated the minimal sample size to be (77) nurses. The sample size was based on a variance of 5%, confidence level of 95% and power of 0.80. Ninety nurses participated in the study (response rate = 90%). This response rate was expected as the Lean awareness educational sessions were developed based on their identified needs and hospital administrator's invitation to conduct the training.

## 2.3 Study measurement tools

Three tools were used in the current study:

### 2.3.1 Demographic characteristics form

A form was developed by the researchers to elicit data on nurses' demographic and work-related characteristics. It included questions related to gender, age, working unit, educational level, years of experience, current position, and working shift.

### 2.3.2 Lean knowledge questionnaire (LKQ)

LKQ questionnaire was developed by the researchers based on review related literature<sup>[22-28]</sup> for assessing nurses' knowledge of Lean concept before and after Lean awareness sessions. It consisted of 14 questions with multiple response formats. Responses on question 1, with yes (1) and no (0), from questions 3-7 responses ranged from completely know (2) to do not know (0), for questions 8-12 responses with know (1) and do not know (0) and questions 2 and 13 responses with number and percentage. Number and percentage also used to present facilitators and barriers in response to questions 8 and 9. A higher score indicated good nurses' knowledge. In addition, question 14 asking about to what extent the participated nurses are satisfied with LASs conducted with responses ranging from very satisfied (2) to dissatisfied (0).

### 2.3.3 Organizational change recipients' belief scale (OCRB)

This scale was developed by Armenakis, et al. (2007)<sup>[15]</sup> was used in this study to assess nurses' readiness for Lean

transformation. The OCRB consisted of 24 items categorized in five dimensions namely: discrepancy (5 items), appropriateness (4 items), efficacy (5 items), principal support (6 items) and valence (4 items). Responses were measured on a 5-point Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree). Mean percent score of more than 66.6% indicates high readiness for Lean transformation, mean score from 66.6% to 33.3% considered as moderate readiness while mean score less than 33.3% regarded as low readiness for Lean transformation.

## 2.4 Validity and reliability

The study tools (LKQ and OCRB) were developed in English language then translated into Arabic and examined for translation, content validity and relevance to suit the Egyptian culture by 5 experts in the field of study. Accordingly, little rewording was done in the tools. Test-retest reliability was done for these tools on 10 nurses to investigate the stability of the tools over time. The test-retest reliability showed a high positive significant correlation ( $r$  ranged from 0.751 to 0.762) for LKQ and ranged from 0.893 to 0.994 for OCRB, respectively. Also, the OCRB questionnaire was examined for reliability by measuring the internal consistency of items using Cronbach's alpha coefficient test. The tool was proved reliable ( $\alpha = 0.939$ ). A pilot study was done on 5% of nurses (n = 5) to check and ensure clarity and applicability of the tools; identify obstacles and problems that may be encountered during data collection with no change occurs.

## 2.5 Procedures

The study was implemented through three major phases: please replace with pre-implementation, implementation and post-implementation phases. The pre-implementation phase included: pre-test, content development, implementation phase represents LASs while post-implementation phase included post-test, and data analysis. See Table 1 for study framework.

- In the Pre-implementation phase, the pre-test was introduced using LKQ to assess nurses' knowledge of Lean before giving LASs intervention.
- The content of LASs was developed based on the related literature review<sup>[22-28]</sup> and nurses' needs based on pre-test result. The handout was revised by the same experts who were validated the tools. Accordingly, little modifications were made, then the final handout was prepared in Arabic language to suit nurses' level of understanding.
- Time and place for the sessions were agreed with nurse managers and nurses according to their shift schedule and off days to avoid affecting their work times and patient care.

- In the implementation phase (LASs), the educational sessions were provided to nurses to raise their awareness about Lean as a quality improvement approach in hospital. Nurses were divided into 10 groups; each group included 8-10 nurses. Each group was provided with two consecutive awareness sessions (twice weekly) to cover the LASs content. Each session took approximately a period of one hour and a half to two hours.
- In the first session, the researchers established the rapport with nurses, and then introduced general and specific objectives of Lean, Lean definition, philosophy and overview, Lean principles, benefits and advantages of Lean implementation, types of wastes/Lean deadly wastes, and managing waste. In the second session, the researchers explained common Lean tools and techniques and discussed with nurses the facilitators and hinders/barriers for Lean implementation in their hospital.
- Content was presented using relevant and interactive teaching strategies according to the information presented including (Lecture, brainstorming, small group discussion, and video presentation). The Handout was distributed to nurses to enhance their learning.
- A total of 20 sessions were conducted to cover all participants. LASs were provided to nurses in their working units or in the rest area between units. Most of the sessions were conducted in the morning shift and some sessions were conducted at evening and night shifts for nurses who assigned to rotating shifts.
- In the post-implementation phase, post-test was introduced immediately after the second session to each group using LKQ to assess nurses' knowledge of lean and evaluate participants' satisfaction with LASs. Also, OCRB was used to assess nurses' readiness for lean transformation in their hospital after attending the LASs intervention. Finally, data analysis was conducted.

**Table 1.** Study framework

Phases	Activity	Tools/methods Used
	-Pre-test	LKQ
	-LASs Content Development	Nurses' learning needs, and relevant literature <sup>[22-28]</sup> Content revised by experts in the field of the study.
Pre-implementation phase	-Intervention implementation of educational sessions (LASs)	Content: General and specific objectives of Lean Lean definition, philosophy and overview Lean principles Types of wastes/Lean deadly wastes (e.g., overproduction, waiting time, transportation, unnecessary motion, inventory, over processing and defective products). Managing wastes Benefits and advantages of Lean implementation Examples of common Lean tools and techniques: Five S program (sort, set in order or simplify, shine, standardize, and sustain) Kaizen approach Fishbone Diagram Why-Why Analysis Deming Cycle (Plan-Do-Check-Act) Facilitators and hinders/barriers for Lean in hospital.
	-Post-test	-LKQ - OCRB
Post-implementation phase	Data Analysis	To determine the effect of lean awareness on nurses' knowledge and readiness for lean transformation at Alexandria German Hospital. The following analyses were conducted: Compare pre-test with post-test scores for Lean Knowledge Questionnaire. Assess nurses' readiness for Lean transformation using OCRB. Determine the relationship between nurses' knowledge and readiness for Lean transformation before & after LASs.

Note. LKQ = Knowledge Questionnaire, LASs = Lean Awareness Sessions, OCRB = Organizational Change Recipients Belief Scale.

**2.6 Data collection**

Written approval was obtained from the administrator of the identified hospital to collect the necessary data. Data were collected and LASs were conducted by the researchers

using the devoped content material and study questionnaires which distributed individually to nurses before and after LASs. Each nurse took approximately 30 minutes to complete all the questionnaires. LASs and data collection were

coordinated to be conducted in the predetermined break time and off days in the nurses shift schedule with agreement of nurse managers and nurses. The data collected, and the intervention provided took a period of four months starting from the first of April to end of August, 2018.

### 2.7 Ethical considerations

Approval was obtained from the Ethical Committee at the Faculty of Nursing, Damanhour University. The privacy and confidentiality of data were maintained and assured. The subject's written consent to participate in the research before data collection was secured. The participants were assured they had the right to withdraw from the study at any time.

### 2.8 Data analysis

Data were coded and fed to the statistical package of social science (IBM SPSS), version 22. For presenting demographic characteristics, frequencies and percentages were used for quantifying the studied variables, mean and standard deviation (SD) were used to present continuous variables. The effect of LASs was analyzed with the parametric test (paired *t*-test) for normally distributed data and non-parametric tests (MH: Marginal Homogeneity test and McN: McNemar test) for abnormally distributed data to compare the pre-test/post-test scores on the LKQ. Pearson correlation coefficient analysis (*r*) was used to test the nature of the relationship between nurses' knowledge of Lean and their readiness for Lean transformation in the hospital. All statistical analyses were performed using an alpha of 0.05.

## 3. RESULTS

### 3.1 Nurses' demographic and work-related characteristics

Table 2 shows that the highest percentages of studied nurses (80.0%, 65.7%) were female and in the age group less than 30 years old. They were distributed across the different working units with the highest percentage (27.8%) working in the I.C.U while 5.6% of them working in the dialysis unit. The highest percentage (65.7%) of them had a bachelor degree in nursing science. Moreover, more than half of nurses (56.6%) had less than 5 years of working experience in nursing. The highest percentage (70.0%) working as bedside nurses while 5.6% working as first-line nurse managers. Also, 76.7% of studied nurses working in rotating shift while 23.3% of them working in morning shift schedule (see Table 2).

### 3.2 Nurses' knowledge of Lean before and after LASs

Table 3 illustrates nurses' knowledge of Lean before and after LASs. The result shows an increase in the overall mean of nurses' knowledge of Lean after attending LASs ( $81.92 \pm 6.52$ ) compared to the mean before ( $39.32 \pm 3.13$ ), which

was statistically significant ( $t = 119.202, p < .001$ ). Significant improvements were found in the overall knowledge of Lean as well as the related concepts in the LKQ.

**Table 2.** Nurses distribution according to their demographic and work-related characteristics (N = 90)

Demographic Characteristics	No.	%
<b>Gender</b>		
Male	18	20.0
Female	72	80.0
<b>Age</b>		
Less than 30 years	59	65.7
30-40 years	19	21.1
41-50 years	6	6.6
More than 50 years	6	6.6
<b>Working units</b>		
PICU	9	10.0
Internal (medical-surgical)	25	27.7
Dialysis	5	5.6
OR	14	15.6
ICU	25	27.8
ER	12	13.3
<b>Educational level</b>		
Bachelor's degree of nursing science	59	65.7
Diploma of Technical Health Institute	8	8.8
Diploma of Secondary nursing school	13	14.4
Diploma of Technical Institute of nursing	10	11.1
<b>Years of experience in nursing</b>		
Less than 5 years	51	56.6
5-10 years	15	16.7
More than 10 years	24	26.7
<b>Current position</b>		
Bedside nurse	63	70.0
In charge nurse	22	24.4
First-line nurse manager	5	5.6
<b>Working shift</b>		
Morning shift	21	23.3
Rotating (morning, evening, night)	69	76.7

The majority of nurses (93.3%) reported that they had no previous knowledge of Lean concept before attending LASs while all nurses reported that they gain knowledge of Lean concept through the LASs ( $^{McN}p = .014$ ). Significant improvements were also found regarding nurses' responses on each of Lean definition, Lean principles, types of wastes/Lean deadly wastes, Lean tools and techniques, benefits and advantages of Lean implementation, facilitators and hinders/barriers for a Lean implementation in the hospital ( $^{MH}p < .001$ ), respectively.

**Table 3.** Nurses’ knowledge of Lean before and after the Lean awareness sessions (LASs) (N = 90)

Q	Variables	Before LASs		After LASs		p
		n	%	n	%	
<b>Previous knowledge of Lean concept and philosophy</b>						
1	Yes (1)	6	6.7	90	100.0	McN <sub>p</sub> < .001*
	No (0)	84	93.3	0	0.0	
<b>Source of knowledge of Lean concept‡</b>						
2	LASs	0	0.0	89	98.9	McN <sub>p</sub> = .014*
	Personal reading	6	6.7	1	1.1	
<b>Basic Knowledge of:</b>						
<b>Definition Lean concept and philosophy</b>						
3	Completely know (2)	0	0.0	67	74.5	MH <sub>p</sub> < .001*
	Incomplete answer (1)	13	14.4	22	24.4	
	Do not know (0)	77	85.6	1	1.1	
<b>Lean Principles</b>						
4	Completely know (2)	0	0.0	56	62.2	MH <sub>p</sub> < .001*
	Incomplete answer (1)	7	7.8	33	36.7	
	Do not know (0)	83	92.2	1	1.1	
<b>Types of Wastes/Lean Deadly Wastes</b>						
5	Completely know (2)	0	0.0	61	67.8	MH <sub>p</sub> < .001*
	Incomplete answer (1)	7	7.8	28	31.1	
	Do not know (0)	83	92.2	1	1.1	
<b>Lean tools and techniques</b>						
6	Completely know (2)	0	0.0	60	66.7	MH <sub>p</sub> < .001*
	Incomplete answer (1)	9	10.0	28	31.1	
	Do not know (0)	81	90.0	1	1.1	
<b>Benefits and advantages of a Lean implementation</b>						
7	Completely know (2)	0	0.0	64	71.1	MH <sub>p</sub> < .001*
	Incomplete answer (1)	5	5.5	25	27.7	
	Do not know (0)	85	94.4	1	1.1	
<b>Facilitators for a Lean implementation in hospital</b>						
8	know (1)	6	6.7	89	98.9	MH <sub>p</sub> < .001*
	Do not know (0)	84	93.3	1	1.1	
	Most reported Facilitators by nurses after LASs:					
	Provision of adequate training, leadership support (n = 89, 98.9%)					
	Respecting nurses’ role in leading innovation and quality improvement (n = 65, 72.2%)					
Effective communication and information sharing (n = 65, 72.2%)						
Having role models, mentors and experts with adequate time for adopting Lean (n = 24, 26.7%)						
<b>Hinders/Barriers of a Lean implementation in hospital</b>						
9	Know (1)	3	3.3	89	98.9	MH <sub>p</sub> < .001*
	Do not know (0)	87	96.7	1	1.1	
	Most reported hinders/barriers by nurses after LASs:					
Lack of Adequate Knowledge (n = 89, 98.9%)						
Poor Management support (n = 19, 21.1%)						
<b>To what extent do you think that the hospital needs Lean implementation</b>						
10	Know (1)	3	3.3	90	100.0	McN <sub>p</sub> < .001*
	Do not know (0)	87	96.7	0	0.0	
<b>Why do you think that the hospital needs Lean</b>						
11	Know (1)	4	4.4	90	100.0	MH <sub>p</sub> < .001*
	Do not know (0)	86	95.6	0	0.0	
<b>Perceived Most applicable LEAN tool in the hospital</b>						
12	Know (1)	2	2.2	89	98.9	MH <sub>p</sub> < .001*
	Do not know (0)	88	97.8	1	1.1	
Frequently repeated tool: (5S tool) (n = 89, 98.9%)						
<b>‡Most applicable functions in the hospital for Lean application</b>						
13	-Healthcare support functions (laundry, accounting, transportation, general administration, etc.)	6	6.7	30	33.3	McN <sub>p</sub> < .001*
	-Patient care and treatment processes	17	18.9	76	84.4	
	-Healthcare functions indirectly involved in patient processes (pharmacy, laboratory, etc.)	2	2.2	33	36.7	
	-Do not know	67	74.4	0	0.0	
<b>Overall awareness and knowledge of Lean concept (Mean% ± SD)</b>		<b>Before LASs</b>		<b>After LASs</b>		t = 119.202 p < .001*
		39.32 ± 3.13		81.92 ± 6.52		
<b>To what extent are you satisfied with Lean awareness sessions provided?</b>		<b>After LASs</b>		<b>%</b>		
14.	Very Satisfied	88		97.8		
	Satisfied	2		2.2		
	Dissatisfied	0		0.0		

Note. ‡Multiple response. MH: Marginal Homogeneity Test. McN: McNemar test, t: Paired t-test, SD: Standard Deviation. \*: Statistically significant at p value ≤ .05. Value of mean % score < 33.3 Low, 33.3-66.6 Moderate, > 66.6 High.

In response to the two open-ended questions asking about perceived facilitators and barriers/hinders to the implementation of Lean, nurses reported that facilitators that could help them to adopt Lean were the provision of adequate training and leadership support (98.9%), respecting nurses' role in leading innovation and quality improvement (72.2%), effective communication and information sharing (72.2%), and having role models, mentors, and experts with adequate time for adopting Lean transformation (26.7%). On the other hand, lack of adequate knowledge (98.9%), and poor management support (21.1%) were the most frequently reported hinders/barriers for Lean.

Regarding the extent to which nurses' knowledge of the hospital's need for Lean implementation, almost all nurses (96.7%) did not know before LASs while all nurses answered they think their hospital needs Lean implementation after attending LASs ( $p < .001$ ). Almost all of the nurses (97.8%) did not know what the most applicable Lean tool in the hospital before LASs compared to 98.9% who reported that "five S" (5S) tool is the most applicable Lean tool after attending LASs ( $^{MH}p < .001$ ).

The highest percentage of nurses (74.4%) responded that they did not know which function or service is applicable in the hospital for Lean thinking/methodology before LASs compared to 84.4% who reported that patient care and treatment processes are the most applicable function in the hospital for Lean application. While, 36.7% of nurses reported that healthcare functions indirectly involved in patient processes (Pharmacy, Laboratory, etc.) are also applicable in the hospital for Lean after attending LASs (McNp  $< .001$ ). Concerning the overall evaluation of Lean awareness sessions, the majority of nurses (97.8%) were very satisfied with these sessions.

### 3.3 Nurses' readiness for Lean transformation

Table 4 reveals the mean percent score and the standard deviation ( $78.82 \pm 13.99$ ) of nurses' overall readiness for Lean transformation, which indicates high nurses' readiness with the highest mean percent score for discrepancy dimension ( $87.0 \pm 14.41$ ) while principal support dimension had the lowest score ( $70.42 \pm 21.22$ ) (see Figure 1).

### 3.4 Correlation between nurses' knowledge of Lean and their readiness for Lean transformation

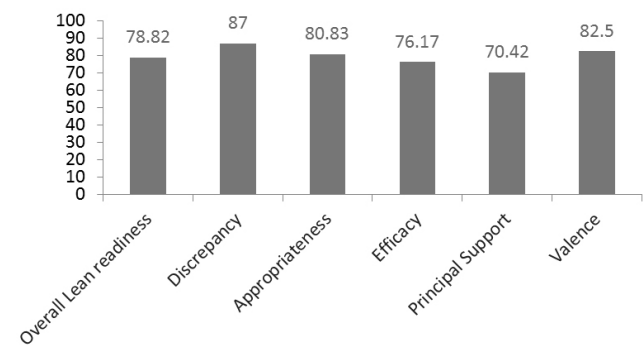
Table 5 indicates that there was a strong positive significant correlation between nurses' knowledge of Lean and their overall readiness for LT after attending LASs ( $r = 0.697$ ,  $p < .001$ ). The same trend was reflected in the relationship between nurses' knowledge of Lean and all dimensions of readiness for LT after attending LASs including discrepancy,

appropriateness, efficacy, principal support, and valence ( $p < .001$ ). On the other hand, there was no significant correlation between overall nurses' knowledge of Lean and their readiness for Lean transformation before attending LASs ( $r = 0.125$ ,  $p = .241$ ).

**Table 4.** Mean score of nurses' readiness for Lean transformation

Lean readiness dimensions	Mean score	Mean Percent score
	Mean $\pm$ SD	Mean% $\pm$ SD
Overall Lean readiness	4.15 $\pm$ 0.56	78.82 $\pm$ 13.99
Discrepancy	4.48 $\pm$ 0.58	87.0 $\pm$ 14.41
Appropriateness	4.23 $\pm$ 0.61	80.83 $\pm$ 15.36
Efficacy	4.05 $\pm$ 0.68	76.17 $\pm$ 16.93
Principal Support	3.82 $\pm$ 0.85	70.42 $\pm$ 21.22
Valence	4.30 $\pm$ 0.67	82.50 $\pm$ 16.84

Note. SD: Standard Deviation, Value of mean % score: <33.3 Low, 33.3 – 66.6 Moderate, >66.6 High



**Figure 1.** Mean % score of nurses' readiness for Lean transformation

**Table 5.** Correlation between overall nurses' knowledge of Lean and readiness for Lean transformation

Lean readiness dimensions		Overall knowledge of Lean	
		Before LASs	After LASs
Discrepancy	$r$	0.080	0.480
	$p$	0.452	< .001*
Appropriateness	$r$	0.048	0.636
	$p$	0.653	< .001*
Efficacy	$r$	0.089	0.553
	$p$	0.402	< .001*
Principal Support	$r$	0.128	0.616
	$p$	0.228	< .001*
Valence	$r$	0.137	0.523
	$p$	0.196	< .001*
Overall readiness	$r$	0.125	0.697
	$p$	0.241	< .001*

Note.  $r$  = Pearson correlation coefficient value: weak from 0.0 to 0.25, moderate from > 0.25 to 0.5, strong from > 0.5 to 1.00; \* $p$ -value  $\leq .05$ .

## 4. DISCUSSION

Understanding the facilitators for any continuous improvement initiative in the hospital is the foundation for success.



Hence, knowledge and readiness factors with constant reinforcement and transformational support will enable nursing staff to be better prepared when they begin their Lean journey. Hence, the aim of this study was to determine the effect of lean awareness on nurses' knowledge and readiness for lean transformation at a private hospital.

The current study revealed a significant improvement in their knowledge of Lean after nurses' participation and attendance of LASs. All studied nurses reported that they gain knowledge of Lean concepts through the LASs as a source of this knowledge. Nurses significantly reported that hospital needs Lean implementation after attending LASs. Additionally, the majority of nurses were very satisfied with these sessions and hoped for their repetition. An assumption of this research is that the difference between pre- and post-knowledge questionnaire rating is a representation of learning that took place. The finding is similar to that of Rybowski et al. (2015) who showed that participants' knowledge and understanding of Lean concepts increased significantly with training or education.<sup>[28]</sup> Likewise, Elbadawi et al. (2010) found that participants' score of Lean principles and its tools improved significantly on post-test knowledge questionnaire which indicated learning growth with training.<sup>[24]</sup>

In this regard, Edmond et al. (2013) highlighted that the implementation of Lean methods in a healthcare setting is difficult when nurses are inadequately informed about Lean techniques, principles, and there is a need for continuous Lean education program and training that always tailored to the needs of nurses.<sup>[29]</sup> Also, Hihnala et al. (2018) accentuated the need for in-depth knowledge on Lean method and principles and understanding of the process of Lean management.<sup>[30]</sup>

In response to the question related to which function in the hospital would be suitable for Lean application, the highest percentage of nurses responded that patient care and treatment processes are the most applicable in the hospital for Lean methodology followed by Healthcare functions indirectly involved in patient processes such as (Pharmacy, Laboratory, etc.). Nurses believe that patient care is the main concern and top priority as the core function and vision of the hospital. This speculation was supported by Johnson et al. (2012) who revealed that the ideal professional to conduct a Lean transformation in a hospital is the nurse because he/she has an active and important role in multidisciplinary teams and is committed to patient care and can view hospital systems from the patient's perspective.<sup>[31]</sup> Also, Shah and Ward (2007) assumed that nurses on a patient care unit reflect the deepest level of diffusion and a nursing unit is where organizational efforts fully affect patient care. So, they should be

adequately trained with Lean.<sup>[32]</sup>

In this instance, the Agency for Healthcare Research and Quality (2014) reported that healthcare providers and front-line staff nurses were most likely to mention improved patient care and efficiency as the goal for their participation in a Lean project.<sup>[33]</sup> A recommendation was pointed out that nursing education needs to be rethought and the curriculum should include concepts, tools, and skills necessary to adopt Lean to the patient care environment.<sup>[34]</sup>

Almost all of nurses reported that the five S (5S) tool is the most applicable Lean tool in the hospital. This might be attributed to the information gained from LASs on how to begin to sort out waste from value added activities. The initial focus was on using simple lean tools like 5S. Nurses enjoyed its information and reported that they would begin its application in their units after attending LASs. In such regard, several researchers pointed to 5S as a methodology considered to be the first step of the Lean journey as the foundation of Lean tools. As it consists of five steps namely: sort, set in order or simplify, shine, standardize, and sustain.<sup>[25,34]</sup>

Several researches highlighted the significant contribution of implementing the 5S as a lean tool in their hospitals. For example, Randhawa and Ahuja (2017) clarified in their study that 5S initiated improvement in production, quality, safety, and effective utilization of workspace.<sup>[35]</sup> Also, Kanamori et al. (2015) concluded that the intervention of the 5S was perceived to have improved quality of healthcare services and staff motivation in a facility with poor-resources and a disorderly work environment.<sup>[36]</sup> On the contrary, Boswihi (2017) stated that the head nurses were not able to use the tool of 5S due to the design of the ward and the poorly disorganized working environment as their wards are crowded with equipment with no storage area.<sup>[21]</sup> In this regard, the Ministry of Health and Family Welfare (2015) stressed that 5S needs to be conducted systematically with the full participation of staff working at the hospital and, it is important to implement 5S as a part of work and daily living activities.<sup>[37]</sup>

One of the prominent findings of this study is the high nurses' readiness for Lean transformation on OCRB. This readiness seems to be related to the knowledge gained on Lean after attending LASs. This speculation could be confirmed by the positive strong significant correlation found between overall nurses' knowledge of Lean and readiness dimensions for LT including discrepancy, appropriateness, efficacy, principal support, and valence. These results prove that the knowledge nurses acquired through LASs increased their readiness in a significant way for LT. In the same line, Holden et al. (2015) confirmed that a clear understanding of principles and methods of Lean may lead to increased readiness and mo-

tivate employees who can immediately contribute to waste reduction efforts in their organization.<sup>[4]</sup>

Likewise, Nordin et al. (2012) clarified, for the change to take hold and success, the organization and its employees must be ready for the transformation. Failure to assess individual (nurses) readiness may result in spending of significant time, energy and hard work trying to implement a Lean project. It is important that those who lead the Lean projects should have the knowledge, skills, competencies, and aptitude to implement Lean transformation.<sup>[19]</sup> Therefore, administrators and managers must spend considerable time and effort in their departments to establish and support the growth of Lean culture.<sup>[17]</sup> Furthermore, Al-Balushi et al. (2016) stated that identifying readiness factors will enable staff nurses to be better prepared as they begin their lean journey. Yet, the lean initiative will be in question if these readiness factors are not addressed.<sup>[38]</sup>

Given special regards to Lean readiness dimensions, nurses rated discrepancy as the highest dimension. This result could be attributed to increased insight and awareness of nurses for the need to adopt Lean after identifying its benefits and their important role in such adoption and implementation processes. Many researchers (e.g. Nordin et al., 2012; Stone, 2012a) have emphasized that urgency (Discrepancy) is required in order to drive organizations to implement Lean.<sup>[19,39]</sup> There is an argument that individuals must believe that a need for change exists and a difference between current and desired performance helps legitimize the need for change. Otherwise, the motive for a change may be perceived as arbitrary.<sup>[40]</sup> The necessity that the proposed change addresses the causes of the discrepancy can be influenced by the information provided by change agents to explain why change is needed.<sup>[13,40]</sup>

On the contrary, nurses rated the principal support dimension as the lowest Lean readiness dimensions. Principal support describes the sustenance of change agents and leaders. This result goes in the same line with what current nurses reported that low management support and leadership are among barriers to any change like lean. Leaders play a useful role in facilitating the success of organizational changes. Leaders as change agents should have valuable information that can be used to initiate an in-depth analysis to determine if the change process should be modified. In the same line, Cinite et al. (2009) in their overview of organizational readiness for change declared that it is vital that the influence of any change to employees' previous work be regarded by leaders with care, due to the employees' perceived value of their own work being in flux.<sup>[41]</sup> In such regard, Poole and Mazur (2010) stressed on leaders' capacity to demonstrate

enthusiasm for and empower the accessibility of resources to guarantee the improvement of Lean activities and strengthen its position in the hospital.<sup>[42]</sup> Also, Al-Balushi et al. (2016) showed that top administration ought to be prepared and willing to exhibit their help for any Lean tasks.<sup>[38]</sup>

This speculation could be supported by what current nurses reported regarding the facilitating factors or barriers for Lean adoption in their hospital. Nurses in the current study reported all the following factors as helpful: provision of adequate training or education, leadership support, respecting nurses' role in leading innovation and quality improvement, effective communication and having role models, mentors and experts with adequate time for adopting Lean transformation. On the other hand, lack of adequate knowledge and training and poor management support were the most frequently reported barriers for Lean or any change.

Similarly, Nordin et al. (2012) and Kaplan et al. (2010) identified certain requirements as essential for successful Lean adoption such as; top-management support and leadership direction, multi-skilled workers, teamwork, transparency of information, rewarding, and open effective communication. In addition to, information sharing, a culture to support continuous improvement, clear responsibilities, a change agent, empowerment, and clear systems and controls to ensure the smooth transition from traditional management philosophy to Lean principles.<sup>[19,43]</sup> By implementing these strategies and tactics, leaders can influence beliefs of individuals (nurses) and consequently affect the degree to which readiness, adoption, and institutionalization occur.<sup>[13]</sup>

#### 4.1 Conclusion and recommendations

In summary, this research focused on the baseline assessment of nurses' knowledge and readiness for Lean transformation as the first step of Lean transformation journey at a private hospital. The current study revealed a significant improvement in the overall knowledge of Lean after nurses' participation and attendance of LASs. Nurses believed in patient care and treatment processes are the most applicable in the hospital for Lean Methodology and 5S is the most applicable lean tool in their hospital. Nurses showed high readiness for Lean transformation; this readiness seems to be related to the knowledge gained after attending LASs. This speculation was confirmed by the positive significant correlation between overall nurses' knowledge of Lean and their readiness. These results indicate that the knowledge nurses acquired through attending LASs increased their readiness in a significant way for Lean transformation. Also, they reported discrepancy as the most significant for readiness while principal support dimension had the lowest perception. nurses reported several both facilitating factors as well as barriers for Lean adoption

in the hospital where they worked that should be taken into consideration for a successful Lean Journey.

#### 4.2 Strengths, limitations, and implications for future research

The strengths of the study included the idea itself (Lean Transformation Journey); this was the first-attempt to develop a lean intervention in a private hospital. Measuring lean hospitals in a systematic way can pave the way for further lean research. Investigators and administrators can measure the progress of their lean programs or the current state of hospital performance. Also, the result of this study may contribute to the identification of the basic requirements for initiating Lean implementation in the hospital such as knowledge and readiness of Lean. The study also may shed light on how definite strategies in specific contexts might influence nurses' initial perceptions of Lean implementation.

It was a real challenge to conduct a scheduled training sessions with busy acute care nurses that have many patient care responsibilities in their units. However, the coordination and cooperation of hospital administrator, nurse manager and staff nurses facilitate the implementation of the intervention. However, several limitations exist in this study. First, the study was conducted only with nurses from one hospital, which was also a private hospital. Therefore, generalization is limited. Second, the present study assessed only nurses' perceptions of Lean-related knowledge and readiness. Subsequent studies are needed to continue the lean transformation process. Also, other variables such as patient safety or patient care quality should be assessed in future studies. Raising awareness in a specialized unit and hospital-based training is needed to ensure that staff is adequately trained to implement lean tools and principles.

**Based on the study findings, the following recommendations are suggested:**

- 1) For successful transformation towards Lean, hospital and nurse managers should consider certain factors that have been reported by nurses as significant such as: knowledge, learning, and training, communication, leadership direction, Lean facilitators, teamwork, clear responsibilities, systems and control to ensure the smooth transition from traditional management philosophy to Lean. Education and training on methods and techniques for implementing Lean must be periodically conducted to prepare and equip nursing personnel with the know-how to raise readiness and confidence in Lean transformation and hence ensure success.
- 2) Revising and updating nursing curricula is recommended for preparing new nurses for Lean work.
- 3) Future research on Lean should also examine context differences, given that hospitals have different conditions and constraints. A second essential future direction is to use rigorous designs, measures, and analyses to understand how Lean adoption impacts nurses, for better or for worse, as well as to demonstrate why Lean's impact on nurses is an important outcome.
- 4) Replication of this study in a wider context and using a control group could help with the generalization of findings. As this study could be a preliminary step for further research, another important recommendation is to apply ongoing data collection in a longitudinal study which will permit stronger statements regarding the causal relationship.

#### CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest.

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