

Effect of Lean Management Strategies on the Quality of Perioperative Nursing Roles

Kawther Abdel Ghafar Ali¹, Hoda Attia Abd El Naby Raslan², Reda Abd El Salam Ibrahim³, Mahmoud Abdel Salam Mohamed⁴

1. Nursing Administration – Faculty of Nursing – Misr University for Science and Technology, Egypt.
2. Medical Surgical Nursing, Faculty of Nursing – Beni-Souf University, Egypt.
3. Medical Surgical Nursing, Faculty of Nursing – Tanta University, Egypt.
4. BSN, MSN, Director of Nursing at Dar Al Fouad Hospital, Egypt.

Abstract

Background: The huge multiplicity of scrub and circulator nurses' activities affects the quality performance of perioperative nursing roles. Therefore, the pursuit of perfect practice of perioperative nursing roles should focus on assessing the performance gaps in these roles and use of lean management strategies for effective patient care delivery. **Aim:** The study aimed to assess the effect of lean management strategies on the quality of perioperative nursing roles. **Design and Setting:** A quasi experimental design was used to implement the study in the operating room at new Dar Al Fouad Hospital, Cairo, Egypt. **Tool of Data Collection:** Observational checklist tool aimed to assess the perioperative nursing roles of scrub and circulator nurses, the tool consisted of two main parts; first part is the performance observation of scrub nurse role, and the second part is the performance observation of circulator nurse role. **Results:** The results of the present study illustrated that the perioperative nursing roles for scrub nurses of met standards performance were improved from above half normal to above three quarter, and the met standards performance of the circulator nurses roles were also improved from less than one fifth to near three fifth with statistical significance difference at $p < 0.005$ for both roles post implementation of the lean management strategies. **Conclusion:** The perioperative nursing roles of scrub and circulator nurses were improved post implementation of lean management strategies which induced positive effect in the elimination of un-value added activities and volume based activities through designing new supportive roles included anesthesia nurse, post anesthesia care unit nurse, surgical technologist, instrumentation technician, nurse aids, store keeper in addition to other relevant roles such as lean team. **Recommendation:** Focused training program is recommended for all OR personnel with periodic evaluations of the perioperative nursing roles and the new supportive perioperative roles. Further research is recommended to disseminate the developed lean management strategies and investigate its effect on the perioperative nursing in different settings.

Key Words: Lean Management Strategies, Quality of Perioperative Nursing, Perioperative Nurses Roles.

Introduction

Lean is a process that continuously eliminates waste and progresses workflow to proficiently create product or service which is perceived to be valuable to the individuals who practice it (Schweikhart

& Dembe, 2009). Lean management introduces principle to get rid of actions or processes that do not add value, straightly to any waste such as longed waiting time of care, duplication of activities. These wastes do not permit the care process to execute without disruption, convolution, backward or lateness. Hence, when these

things are eliminated, efficiency of activities and services will be simultaneously raised (Toussaint & Berry, 2013).

Performance efficiency in the operating rooms (ORs) relies on minimizing of waste and unemployed time to meet planned surgical objectives as there are several factors that impacts on OR productivities e.g. accuracy of surgical schedule, on time starts, minimizing cancellations of cases and time of patients turnover (NSW, Agency for Clinical Innovation (ACI), 2014). Lean management strategies have been utilized in many countries to improve process efficiency, financial performance and productivity of operating room (Stoutzenberger, 2014; Geedey, 2015; Hassanain, et al., 2017).

The work in perioperative environment is commonly volume-based aiming to increase level of productivity. Therefore when healthcare is transitioning to value-based service, it is critical for OR nurses to have adequate knowledge on the local standard that focusing on the safety of patients, environment and OR team; prevention and control of infection; implementing evidence-based practice (EBP) that reinforce efficient perioperative services and cares (Spruce, 2015). Also, in a study about "responsibility for patient care in perioperative practice" Blomberg, et al., (2018) pointed that perioperative nursing carry out all nursing activities correlated to the surgical management, organization and leadership of perioperative practice. In addition to the technological advancement in OR, which produced many challenges that necessitate increase of qualified and specialized OR nurses who should achieve continuous growth in clinical competences in perioperative nursing (Smith & Palesy, 2018).

Internationally, the perioperative nurses are practicing various roles, includes scrub nurse, circulator nurse, clinical nurse specialist, registered nurse first scrub assistant, educator, and researcher. Within these roles, the perioperative nurse is responsible to; assesses patient before, during, and after surgery; advocates patient; teaches, supports and reassure patient and family; performs as scrub or circulator nurse during surgery; controls operating room environment; allocates resources efficiently; supervises ancillary staff; coordinates, collaborates, and consults with the members of healthcare team; maintenance of asepsis; and continuous monitoring of the patient's status (Goodman, Spry & Burlington, 2017).

According to the perioperative environment in Egypt, an expatriate chief surgeon at Harpur Memorial hospital in Menouf City, reported that the Egyptian surgeons and the anesthesiologists design OR policies to primarily meet their needs and desires, that makes them as the sole guards, even with low paid attention to patient safety as evidenced by frequent breaks with sterile attire, and limited cleaning time of the OR before and after operations. There was also a wide gap in the authority and responsibility between doctors and nurses due to the big difference in their educational levels because OR nurses and ancillary personnel often don't even have high school degrees and there was almost absence of formal training in concern to patient safety and other critical areas related to operating room procedures. Nurses don't see themselves as important team players whose performance or lack of performance affects patient outcomes. Instead, they see themselves as employees whose job is to serve doctors quickly and without discussion. If they see practices that adversely affect patient care, it is not up to them to point them out, unless they want to

lose their jobs. Moreover, OR nurses feel ashamed to make older surgeons wait. Thus, culture change in the surgical environment is imperative (Thompson, 2019).

Significance of the Study

From the early beginning until present there are limited changes in the roles of the operating room nurses in particular in wide range of general and small hospitals in the developing countries, as these roles are mainly interchangeable between the scrub and circulator nurse with limited presence of the anesthesia nurse role and other healthcare professionals supporting the workloads of OR. Operating room nurses are usually seen as subordinate, equipment guard, and plays only technical roles. Therefore, the present study aimed to assess the effect of developed lean management strategies on the quality of perioperative nursing roles through assessing the perioperative nursing roles, implementing new supportive roles to induce changes in the perioperative roles and give these nurses an opportunity to enhance their competence to achieve evidence for practice, protocols, technology updates, and to believe that patient safety standards are valuable and functional.

Aim of Study

The present study aimed to assess the effect of lean management strategies to improve the quality of perioperative nursing roles through (a) conducting observations based assessment for performance practice of perioperative nursing roles (scrub and circulator nurses), (b) identifying the performance gaps in these roles, (c) design and implement new supportive roles in the delivery of perioperative nursing services.

Research Hypothesis:

It was hypothesized that through using lean management strategies, a positive effect on the quality of perioperative nursing roles of scrub and circulator nurses' will be achieved.

Operational Definition:

The perioperative nursing roles of scrub and circulator nurses indicates to the clinical process or the clinical data of the technical skills of both roles.

Lean management strategy is a universal management tool used in any business or production process for optimizing work flows that relies on deliver value; eliminate waste, and continuous improvement.

Materials and Methods

Study Design:

A quasi experimental study design was used to evaluate the effect of the new developed strategies of lean management on the perioperative nursing roles. The quasi-experimental design is mostly utilized to evaluate the effect of particular interventions in the absence of randomization (Collins, et al., 2014).

Study Setting:

The study was implemented in the operating room at new Dar Al Fouad hospital which located at Nasser city, Cairo, Egypt. The hospital has 300 bed capacities, while, the operating room constructed with five rooms that serving different types of surgical operations. Three rooms only were utilized during the study and the other two rooms were not equipped to operate surgeries.

Study Subjects:

A convenience sample of 32 nurses was enrolled in the actual observations during the three perioperative phases. These nurses were working on full time at the time of the study and interchangeably performing scrub and circulator roles, while anesthesia role was planned to work but not yet present.

Tools of Data Collections:

Tool (1) Structured Interview Questionnaire. It aimed to assess the personal characteristics of the studied nurses, which included; age, gender, marital status, level of education, years of experience in OR, prior training related to operating room protocols, guidelines, infection control and source of up-to-date information.

Tool (2) Observation Checklists of Perioperative Nursing Roles. It is a standardized tool adopted from (Berry & Kohn Operating Room Techniques, 13 editions, 2017), and constituted from two main parts.

Part One: Observation checklist of Scrub Nurse Role:

The tool aimed to assess the roles of the scrub nurses which consisted of 57 performance observation statements (including fifteen domains and forty two sub-domains). The domains of the scrub roles titled: Report for duty in a punctual manner; Wears OR attire properly; Performs housekeeping duties; Sterile supplies; Places items on sterile surface; Scrubs for setup and procedure; Gowning; Gloving; Sterile setup; Accountability; Anticipates needs of surgeons; Counts; Assembles instruments; Disassembles the tables; Removes gown and gloves.

Part Two: Observation checklist of Circulator Nurse Role:

The tool aimed to assess the roles of the circulator nurses which consisted of 66 performance observation statements (including fifteen domains and fifty one sub-domains). The domains of the circulator roles titled: Report for duty in a punctual manner; Wears OR attire properly; Performs housekeeping duties; Sterile supplies; Dispenses or transfers items to sterile surface as appropriate; Validate implant parameters and documents in the lot log; Practices aseptic technique; Gowning and gloving of others; Accountability; Anticipates needs of patient, anesthesia provider, surgeon, and others team members; Provides safe and competent direct patient care; Counts; Attaches and activates surgical machinery and devices for the sterile field; Supervise and manages the room; Computer literacy.

Scoring System:

The performance practice of both scrub and circulator nurses was measured by two points of Likert scale (meet standards = 2, and does not meet standards =1). The main domains and sub-domains that described the performance roles of nurses were computed in number and percent, then the total sum of each group related to the parameters of meet standards and not meet standards of performance roles were calculated in a form of number and percent for identifying the performance gaps in the scrub role and circulator role before and after the implementation of lean management strategies to evaluate its effect.

Validity:

The tool was reviewed by two groups of professional experts; first group composed of three academic staff (Professor and Assistant Professor of

medical surgical nursing at faculty of nursing, Mansoura University and Tanta University, in addition to Assistant Professor of nursing administration at faculty of nursing at Benha University. The second group composed of two clinical experts from the study setting, the operating room head nurse and nursing supervisor. The experts' groups agreed that the tool was feasible, and adequately covers all relevant domains and sub domains for assessment of the perioperative nursing roles. The tool also was predictive for the gap in measured roles.

Reliability:

The reliability was checked by examining the internal consistency of the observation checklists in measuring the perioperative nursing roles. The Cronbach's alpha of the test was 0.88 indicating good reliability.

Pilot Study:

The tool was tested on 3 nurses (10% of the total sample) to check the applicability of main domains and sub-domains which illustrate the roles of the scrub and the circulator nurses. All variables were applicable to the perioperative nurses and to the OR setting, no items were added or cancelled or modified in the original tool, and therefore the piloted nurses remained in the total sample during the study.

Field Work:

The study started on March 2019 and continued for eight weeks to obtain the primary assessment of the scrub and circulator nurses' roles which observed during the three perioperative phases (preoperative, intraoperative and post-

operative) two nurses were observed for both roles every visit during the day shifts (12 hours shift) and a copy from the working schedule was received including a list of nurses' names and pattern of working shifts in addition to a copy of daily assignment according to the OR list of cases to guide and facilitate of researchers' observation at each visit. Prior confirmation about the long OR list was applied before each visit, two visits in two separate days were scheduled every week. The number of observed operation was not fixed as it was based on the observed activities for the scrub and circulator nurse roles. The time consumed in the data collection of each nurse roles was approximately the time consumed in two-to-three minor surgeries or one major surgery (approximately 2-3 hours).

Based on the collection and analyses of the performance practice of the scrub and circulator nurses' roles, the researchers identified the performance gaps and prepared lean management strategies that are relevant to OR functions and assigned new supportive roles to decrease the volume based activities and eliminates the non-value-added activities done by the perioperative nurses. The strategies were written and submitted to the director of nursing who approved on them and validated the acceptance from the medical director of OR. The data collection post implementation of lean management strategies extended from one and half month to two months. The study was ended on September 2019.

Implementation of Lean Management strategies

The researchers assigned the four nurses with bachelor degree for the anesthesia nurse role and post anesthesia care unit (PACU) role, until extra staff be hired based on the new nursing database modification planned with the director of

nursing. Instruments technician was selected from the surgical sterilization department, and the surgical technologist was selected from the workers who was serving in the intensive care units and based on personal and technical criteria such as basic education, work experience with machines and equipment. The surgical aids were selected from the inpatients units with ability to read/write, ability to assist in patient positioning, and transferring. Store keeper was recruited from the main store house of the hospital. Staffing plan for replacement was initiated by the director of nursing.

The allocation of these personnel consumed one month to start working in the new roles, then researchers prepared an orientation program to train the new candidates to their roles in collaboration with other departments such as biomedical engineering department and surgical sterilization department and anesthesia physicians. The researchers had evaluated the effect of the implementation of lean management strategies after three months of commencement of OR personnel in new designed roles.

Lean Team or Safety Team:

- The "lean team" or "safety team" is formed from two of the most competent perioperative nurses performing scrub role who shared the responsibilities of the team with another two nurses from those who were assigned to perform anesthesia role.

- The responsibility of this team is to fulfill the gap in practices of the operating room nurses with adopting sensitive quality indicators related to operating room interventions such as surgical site infection, compliance to safety practice and hand hygiene, medication administration, patient monitoring, documentation, cost reduction and best OR utilization.

- The team is accountable to work on the OR variances of sensitive quality indicators from the set targets and report to OR nurse supervisor/manager.

Anesthesia Nurse:

- Accurately receive patient and check order for operation, consent, labs, and reserved blood/blood products.

- Assist in induction of anesthesia.

- Deliver nursing care before, during and after surgery.

- Monitor patient physiological and psychological status.

- Provide pain management services.

- Provide anesthesia services during emergency situation, such as airway management.

- Administers anesthesia for all types of surgical cases, from the simplest to the most complex.

- Transition patient from OR to post anesthesia care unit/intensive care unit/ward room.

Post-Anesthesia Care Unit (PACU) Nurse:

- The responsibility of PACU nurse is to manage the outsider of the theater.

- Receiving patient from and transferring to unit "transition journey of patients" with ensuring of accurate patient identification and the other safety procedures.

- Contact the laboratory to standby requesting the reserved blood and blood products.

- Contact the patient unit before the scheduled time of surgery to pre-medicate the patient with the antibiotic prophylaxis/pre anesthesia drug and for preoperative preparation according to the infection control policy.

- Assist the anesthetist for outsider procedures such as difficult intubation, central line insertion, insertion of difficult peripheral line, extracting atrial blood

gasses, and assist in cardiac catheterization and endoscopic sedation.

- Respond to code blue outside OR.

Instruments Technician:

- The main responsibility is to liaison between the operating room and central sterilization department (CSSD).

- To assist with the scrub and circular nurse to eliminate the setup and turnover time between surgeries.

- Attend with scrub nurse during instrumentation set up and counter count the instruments before and at the completion of the procedure, then handle this instrumentation to CSSD.

- Responsible to back up the operating room department with all requested instruments according to the daily operating room list.

- Some surgeons prefers to use their special tools, the technician should also, be responsible for this tools sterility and returning them back to the surgeons.

- Keeping and maintenance of the surgical tools, and instruments is also a part of the technician responsibility.

- Updating the instrumentation lists based on surgeons preferences and scrub nurse preferences.

Surgical Technologist:

- Prepare anesthesia machine, monitor and maintain them in standby mode.

- Prepare operating table with accessories according to the type of surgery and position of patient.

- Prepare and check diathermy machine.

- Prepare and test OR gases, vacuums and air pressures.

- Replace suction and be ready for emergent situation which may require defibrillator shock.

- Liaison with the biomedical engineering department for sporadic and regular maintenance of OR machines and devices.

- Assist company vendor during surgery as needed.

Surgical Aid:

- Prepares the operating room by cleaning and disinfecting surgical table, surfaces and others equipment.

- Prepares the patient for surgery by washing, shaving and disinfecting incision sites.

- Assist for transporting patient in and out operating room, and in positioning scrubs.

- Assist scrub nurse in lifting patient for complete skin preparation.

- Assist surgical team in handling personal protective equipment (PPE):gloves, masks and gowns the surgical team as needed.

- Assist company vendor in transporting their surgical utensils and devices bags.

- Gather sharp containers and all surgical wastes from the theatres and dispose them according hospital policy.

- Prepare and replace new incineration boxes.

- Transports patient to the PACU room and cleans the operating room for the next procedure.

Store Keeper:

- Operating room is a place packed with medical and surgical supplies in which replacement, arrangement and storage, are consuming a lot of time and efforts that destroys the energetic capacity of the operating room nurses.

- So recruiting a store keeper will serve indirect roles of the scrub and circulator nurses.

- Medical and surgical supplies should be listed based on the types of surgeries, at least for major and most common surgeries.

- The store keeper should also assist the circulator nurses in charges of medical and surgical supplies on each operation to maintain the surgical cost.

Strategies related to staff education development:

- Continuous training programs for OR personnel and attending work related work shop and seminars.

- A procedural hand book specific to surgeons' preference cardex in Arabic language.

- Create staff mix plan based on development of new supportive roles.

- Disseminate up to date knowledge and practices related infection control guidelines and recommendations by providing various methods of teaching and learning simultaneously.

- Continuous counseling of infection control policy and procedures for guiding operating room nurses should be established.

- Allow operating room nurses to participate in infection control committee meeting alternatively.

- Encourage operating room nurses to act the role of the link or liaison infection

control nurse by rotation with rewarding the best practicable and advisable one.

- Communicates results of surgical site infections (SSIs) to all operating room team members and monitors aseptic procedures to avoid risking patient safety.

Ethical Consideration:

Formal approval on the implementation of the study was obtained from the OR manager and the director of nursing and the operating room nursing supervisor based on the discussed aim of the study. The director of nursing introduced the researchers to the available OR nurses and explained the staffing pattern of the operating room nurses, and the researchers reassured the participated nurses and explained the purpose of the study as well as the plan for data collection and asked for a copy of the working schedule of nurses to adjust attendance for observing them during operations, in addition to a list of operations and permission to do phone contact before attendance to be sure from no cancellation of operations.

Statistical Analysis:

Statistical analysis by using an excel spread sheet was used for calculation of frequency distribution of variables in the form of number and percentages of observed performance of scrub and circulator nurses roles. The differences in variables between pre and post interventions was analyzed by chi square test for the outcome with statistical significance difference at $p < 0.005$ and high statistical difference at $p = 0.000$.

Results

Table (1) displays that 53.1% of nurses have age group from 26-35 years, and 84.4% of the perioperative nurses were females, and 59.4% were married. Regarding the qualification 50% had nursing diploma degree, and 37.5% got experience ranged from 6-10 years. A 68.7% of the nurses have no prior training on operating rooms protocols, standards, guidelines, infection control. The main source of up-to-date information among the surgical team was the nurse mate by 71.9%

Table (2) reveals the perioperative roles assessment at pre implementation of lean strategies as most of the scrub nurses met the standards respectively in performing sterile setup and gowning 87.5%, scrubs for setup and procedures 84.4%, places items on sterile surface 81.3%, gloving and assembles instruments 75.0%, removes gown and gloves 71.9%. While more than half of them meet the standards respectively disassembles the tables 68.8%, plan and gather sterile supplies 65.6%, counts 56.3%, anticipates needs of surgeons 53.1%, and wears OR attire properly 50.0%. Conversely, for the statements roles that did not meet standards were respectively for reporting to duty in a punctual manner 78.1%, performs housekeeping duties 56.3% and accountability 53.1%. Comparing these results to post implementation of the lean management strategies, the roles were improved with high statistical significance difference, respectively in counting and disassembles of tables, wears or attire properly, and reporting for duty in a punctual manner.

Table (3) reveals the perioperative roles assessment at pre implementation of lean strategies as 78.1% of the circulator nurses met the standards performance in gowning and gloving of others, 59.4%

sterile supplies, 56.3% supervise and manages the room, and 50.0% wear OR attire properly and do counts. Conversely, for the statements roles that did not meet standards were respectively in computer literacy 90.6%, dispense or transfers items to sterile surfaces as appropriate 87.5%, validate implant parameters and documents in the lot log 78.1%, report for duty in a punctual manner 75%, accountability 71.9%, providing safe and competent direct patient care 71.9%, practices of aseptic technique 68.8% and, attaches and activates surgical machinery and devices 62.5%.

Comparing these results to post implementation of the lean management strategies, the roles of the circulator nurses were improved respectively with high statistical significance difference at $p=0.000$ in accountability, validates implant parameters and documents, gowning and gloving of others, practices of aseptic techniques, performing housekeeping duties, and punctuality of nurses and computer literacy.

Figure (1) illustrates the total practice of performance levels for the roles of the scrub nurses before implementation of lean management strategies as meet standards presented 53.1% while not meet standards was 46.9% which compared to 78.1% meet standards and 21.9% of not meet standards post management of lean strategies.

Figure (2) illustrates the total practice of performance levels for the roles of the circulator nurses before implementation of lean management strategies as meet standards presented 18.7% while not meet standards was 81.3% which compared to 59.4% meet standards and 40.6% of not meet standards post management of lean strategies.

Discussion

The current OR setting were included two roles of perioperative nurses who were working interchangeably for scrub and circulator roles without job boundaries and unavailability of anesthesia nurse role and other supportive roles. This tight range of roles is a controversial issue which makes nurses overloaded as task oriented only and may not give time for patients' safety and for them to search for evidence based related surgeries and patient care needs. The overlaps in the roles of the operating room nurses are function in wide ranges of tasks and activities which should be eliminated to clear roles focusing to direct patient care activities and uses of technology.

Therefore, the present study aimed to assess the effect of lean management strategies to improve the quality of perioperative nursing roles through (a) conducting observations based assessment for performance practice of perioperative nursing roles (scrub and circulator nurses), (b) identifying the performance gaps in these roles, (c) design and implement new supportive roles in the delivery of perioperative nursing services.

Perioperative nursing is patient central, not task oriented. The term "perioperative" stands for all three distinct phases, which includes: preoperative, intraoperative, and postoperative, (**Rothrock, 2015**). In all phases, **Sandelin & Gustafsson, (2015)** pointed in a study titled "OR nurses' experiences of teamwork for safe surgery" that the OR nurse acts a central role using the nursing process to personalize care and meet the surgical patient's exact needs and facilitate surgical performance and develop possibilities for a good outcome for the patients. In this background **Jones and Johnston (2018)**, epitomized in a study about "managing gaps in the continuity of nursing care to enhance patient safety" that nurses can use effective nursing strategies

to identify and manage gaps in hospital settings to create safety.

The demographic characteristics of the current perioperative nurses under study displayed that more than half of them have age group from 26-35 years, and most of them were females. Only one eighth of them have bachelor degree on nursing who were shifted from scrub role to anesthesia role after implementation of lean management strategies. The diploma nursing school constituted 50% of the nurses and more than one third has technical health institute degree of educations. Regarding the years of experience in OR, more than one third gathered experiences from 6-10 years, and more than one quarter have less than 5 years of experience respectively. Regarding previous training, more than two third has no training.

According to **Alaa-Eldeen, et al., (2012)** in evaluation of nurses on safety practice of intraoperative surgical cases at Alexandria Main University Hospital in Egypt displayed some similar findings related to demographic characteristics such as (100%) of nurses had diploma nursing secondary school, about half of the nurses had experience from 15 to less than 25 years, less than quarter had less than five years of experience and nurses experience of more than twenty five years was not present which were paralleled to the current study in addition, the majority have no previous training.

In private hospital long experience are not frequently seen compared to governmental hospitals due to work insurance. **El-kady, (2010)** stated that prolonged experience and attending educational training progress the performance of nurses effectively. Also, **Blomberg, Lindwall, & Bisholt (2019)** in a study about "self-reporting of clinical competence in perioperative nursing"

stated that long professional experience support the work of OR nurses more proficiently irrespective of the surgical type.

Regarding the degree of qualification of current OR nurses, the present study result revealed that one eighth only of nurses have bachelor degree of nursing and even no OR specialty training were present, while one half of them had diploma nursing degree which may restrict or limit those nurses to upgrade their educational level and may cause deficit on learning development due to language barrier and informatics barrier. According to the recent study of **Blomberg, Lindwall & Bisholt (2019)** educational degree and working experience of OR nurses were important for the development of clinical competency which impact on their collaborative leadership within the team.

At the same background, **Crafoord & Fagerdahl, (2017)** pointed that bachelor's degree is not sufficient for working as OR nurses, because perioperative nursing necessitates more advanced knowledge in health science and research which is achieved through formal education of bachelor's degree and post graduate education, other technical specialized information is needed about gadgets, instrumentation and disinfection processes which is utilized in OR and safety measures to prevent patient injury, accordingly, considered OR professionals with postgraduate education is fundamental for full comprehension of the entire patient needs in the perioperative setting. Also, in a study titled nurse staffing and education which conducted in nine European countries by **Aiken, et al., (2014)** who asserted that nurses with bachelor degree are associated with better-quality of patient outcomes, as they have more professional style, communicate more proficiently and apply problem

solving skills according to different situations.

The majority of the current participated nurses have no prior training on operating rooms protocols, standards, guidelines, infection control, drug usage, monitoring patient post anesthesia. A significant number of studies (**Belowska, et al., 2014; Famakinwa, et al., 2014; El-Sayed, et al., 2015; Teshager, et al., 2015; Qasem and Hweidi, 2017**) have demonstrated that healthcare providers don't have adequate information to avoid surgical site infections, evidence-based protocols and guidelines are not being applied effectively, there fore, healthcare providers need knowledge. However, the educational preparation of healthcare providers can improve the degree of knowledge, which advances the utilization of infection control measures and rules that will decrease wellbeing related diseases (**Belowska, et al., 2014**).

The present study showed that most of the nurses considered the operating room nurse mate as the main source of up-to-date information, followed by surgeons. This result agreed relatively with the result of **Cawich, et al., (2013)** who assessed the practicing measures of infection prevention adherence by OR nurses in developing country, and concluded that nurses' knowledge attained mostly thoroughly informal communicational channels and independence inquiry.

Regarding the performance observation of scrub nurses roles, the present study results revealed that most of the scrub nurses met the standards performance respectively in sterile setup which included drapes of tables, mayo stand and positions of sterile instruments in the field, this part was the most perfect role after implementation of lean management strategies with statistical significance difference because it is a

primary role for the scrub nurse. This result was consistent to **Wistrand, Falk-Brynhildse & Nilsson, (2017)** that most of scrub nurses do sterile drapes correctly. Meanwhile was dissimilar to **Alaa-Eldeen, et al., (2012)** who reported that sterile drapes done correctly for only more than half of patient underwent surgeries. This difference may be due to over whelming of scrub roles which are not supported by further OR personnel in the governmental hospitals.

The current study result revealed through the role of scrub nurses in placing items on sterile surfaces that most of them met standards in opening wrappers, but peel packages and dispensing solution, these two techniques were done incorrectly before implementation of lean strategies, because scrub nurses don't use drips to pure solution but the circulator nurse use a knife to make a hole in the solution tube after disinfect the site then squeeze the bottle to pure the solution to a sterile bowel when needed during surgery. This technique was improved post lean strategies as a result of researchers' instructions. **Kelvered, Ohlen & Gustafsson, (2012)** highlighted that OR nurses are responsible to maintain sterile surfaces and a septic environment throughout the operation for the use of surgical instrumentations and patient draping to avoid wound contamination.

The present study revealed that before implementation of lean management strategies the majority of OR nurses were gowning self correctly and gown surgeons. Also, gloving them self and others and change contaminated gloves. While, almost half of them met the standards in wearing OR attire, dons' personal protective gear and radiation badge as needed. These procedures were improved post implementation of lean strategies by most of scrub nurses with statistical significance difference. In line

with the study of **Awadalla, Garas and Hanafy, (2019)** at Cairo university hospital in Egypt, the finding shown that nurses compliance was lowing gowning, handling sharp instruments and nil with goggles, moderate level for over shoes while it was high for head gear and wearing surgical masks. While in another study conduct in Egypt at El-Demerdash hospital by **Hakim, Abouelezz & El Okda, (2016)** the nurses were using personal protective equipment especially aprons, eye protection significantly less frequent than surgeons which was proven in their study related to practicing of personal protective equipment by nurses and surgeons.

The present study revealed also that most of scrub nurses before implementation of strategies and with trivial increase post lean management strategies, as the nurses had done scrub for setup and procedures that included hand & arm scrubbing and hand hygiene with hand antiseptic, which contradicted with **Awadalla, Garas and Hanafy, (2019)** as there was low compliance of surgical hand washing. The gap in hand hygiene compliance was interpreted previously by **Lohiniva, et al., (2015)** in their study about assessment of nurses behaviors on hand hygiene in two university hospitals in Egypt, which clarified that the need for hand hygiene comes from the sense of dirtiness and preference to use soap and water instead of other chemical products for disinfection, also, knowledge related hand hygiene and used products was inadequate. **Adriana & Sarmiento, (2015)** evaluated intra-operatively the practices in 18 surgeries and concluded that a partial adhesion to pre- and intra-operative practices were recognized, so there is a need for more attention to apply measures to prevent surgical site infection.

The present study result illustrated that more than half of the scrub nurses

anticipates needs of surgeons in the form of passing instrumentation, prepares and applies dressing materials, and coordinates with circulator nurse. The expert scrub nurses were preparing and loading sutures when needed according to wound condition to save sutures wasted by surgeons. Before the implementation of lean management strategies, frequent distraction noticed inside the operating rooms while the doors were left open, doctors and circulator nurses traffics across the rooms, beside this behaviors many times the scrub nurses were left alone. **Mitchell, et al., (2011)**, reported in a study about "thinking ahead of the surgeon" that OR nurses use their prior skilled experience to infer body movement cues of surgeon in order to act ahead in the surgical scene and to be aware with situation surrounding. At the same line, **Sandelin & Gustafsson, (2015)** consoled that OR nurses must be one step ahead and follows the surgeon's technique through overviews the surgical site continuously.

Shortage of perioperative nurses can be solved through allocation of nurse allied or aids to assists in circulator roles and to avoid leaving alone the scrub nurse during surgical procedure being struggle for calling someone to handle her with needed supplies. In this regard, **Sandelin & Gustafsson, (2015)** confirmed that added roles to circulator nurse can be achieved by nurse aids. Moreover, **Blomberg, et al., (2015)** in a study titled "OR nurses' perceptions of caring in perioperative practice" the authors epitomized that OR nurse is in charge for preventing the flow of traffic between OR rooms. However, opening of operating room door sat the time of surgery influence air pressures, and could permit tainted air to stream in and lead to inadmissible quantities of airborne microbes, conveying particles and conceivably bring about careful site contaminations (**Andersson, et al., 2012**).

The finding of the present study revealed that the majority of scrub nurses assemble instruments such as attaches' blades on handles, loads or prepares sutures and tests drills and devices. Removes gown and gloves involved gown off first and glove-to-glove/skin-to-skin, disassembles the tables' follows proper disposal of items and perform decontamination procedures. After implementation of lean management strategies, practicing of these procedures was improved with statistical significance difference, due to granting of more time to outfit scrub activities perfectly. The present study also illustrated that only more than half of the scrub nurses met the standards of sterile supplies when plans and gathers the instruments required for surgery, while integrity of packages, sterility integrator and dates on perishables were checked infrequently due to rapid turnover of cases. This finding was disagreed with **Sabbour, et al., (2015)** who reported that sterility of instruments were not checked by the OR nurses.

The present study revealed that only more than half of the scrub and circulator nurses met standards in counting of sharps, sponges and instruments. Prior the implementation of lean management strategies, the nurses were observed to do counts during surgeries only if they were unascertained of retained foreign body and based on surgeon preference for those who think in obsessional manner, as well as the nurses were observed to do counting only when emergency situations encountered surgeries. The OR nurse's must check the quality conditions of instrumentation, then do counting for instruments, gauze, towels, needles encountered with the circulator nurse who should document the numbers in the intraoperative tally sheet, which should be proceeded before the starts of surgery, during and before closure of wound and after the operation to be sure of no retained objects left by mistake in the

patient body. Post implementation of lean management strategies, counting procedures were improved with statistical significance difference, as the scrub and circulator nurses were synchronizing counting without involving the surgeons unless otherwise there was error in counting or retained foreign body was suspected. This attitude also reflects lacking of leadership abilities in the OR.

The current result was matched with **Fekry & Ali (2015)** as counting was occurred in more than half of cases. Meanwhile, on contrary with **Candas, et al., (2017)** almost all participants' nurses reported that instruments and sponges were commonly counted by the scrub nurses. Prevention of retained objects at the surgical site is the most top priority in patient's safety that must be recognized by OR nurses (**Steelman, Graling & Perkhounkova, 2013**). Positioning of surgical instruments and swabs is a specialized obligation which is joined by nontechnical knowledge related to instrumentation placement, and nurses' leadership or decision making during surgical operations as soon as these instruments are out-of-place, the nurses must speak up for conforming counting (**Mitchell, et al., 2011**).

Conversely, most of scrub nurses did not meet standards performance in performing housekeeping duties which included all preparation before, in-between and after completion of OR list of surgeries. After implementation of the lean management strategies, these housekeeping duties were more deteriorated with statistical significance difference, due to the presence of other OR supportive personnel who became responsible for these duties under the supervision or with assistance of scrub and circulator nurses. At the same time few nurses liked to do these duties by themselves. Before the implementation of lean

management strategies, the majority of nurses were reporting for duty in a punctual manner. After the implementation of lean management strategies, the punctuality of nurses was improved with statistical significance difference, as there was a time for rest and to leave duty on time.

In this subject, **Kisacik & Cigerci (2019)** asserted that the time allocated between operations for performing housekeeping duties is required for OR nurses to make special preparations necessary for the following operation, hence all organizations must consider this time by providing significant support to assist these nurses, who are enthusiastic and energetic in implementing the procedure checklist efficiently.

Regarding accountability of OR nurses, prior the implementation of the lean management strategies, the present study revealed that slightly more than half of scrub nurses and majority of circulator nurses do not meet standard performance in participation of safety timeout before incision, labels solutions and drugs, reports amount of use, maintains the sterile field, responds appropriately to emergent situations, gathers and checks solutions and drugs for use on the field, documents amount of usage of drugs and solutions on the field, practices safety for the patient and team, monitors the sterile field and the members of the sterile team. After the implementation of lean management strategies, the percentage was increased with statistical significance difference, especially with the circulator nurses that reflected their further needs for specific training and knowledge related to proper application of safety surgical procedures. The documentation was improved by the circulating nurses and done on time during surgery plus patient charges as a result of runner time outside the surgical room was eliminated.

In context with **Sabbour, et al., (2015)** who supported that nurses working in the operation rooms of Police Hospital in Cairo showed low compliance with the use of safe surgery checklist, instruments sterility, operating room doors closed unless necessary. According to **Spruce, (2015)** operating rooms staffs responsible for the delivery of care and must have an ability to assess patients critically and the given care, appraise research outcome and evaluate the availability of evidence to define its integration into clinical practice. **Kisacik & Cigerci (2019)** clarified that culture change of patient safety and collaboration of surgical team must be encouraged for applying constant and appropriate surgical safety checklist.

Documentation is one of the prerequisites activities for perioperative research and quality improvement (**Westra & Peterson, 2016**). OR nurses are responsible for documenting the operation specific nursing care, that is, planned and performed nursing activities such as positioning, assessment of skin status before and immediately after surgical procedures, skin preparation and draping, surgical equipment and materials used, including implants, to ensure traceability (**Swedish Institute of Standards, 2019**). Research studies advocate that improved care efficiency is based on the harmonization of inter-professional communication that has a consequential effect on the flow of patients (**Gillespie, et al., 2016**).

Regarding the performance observation of the circulator nurse roles, the results displayed that the majority of them met the standards performance in gowning and gloving of others which including ties gowns for sterile team members, assists with contaminated glove removal and provides additional gowns and gloves as needed. The performance of

these procedures was improved by most of the circulator nurses after implementation of lean management strategies. In context with the observational study of nurses' practice by **Ding, et al., (2017)**, it was reported that more than one third of nurses were not accurately using clean gloves, and another one fifth were not correctly using sterile gloves.

The current study revealed that nearly two thirds of the circulator nurses met standards in sterile supplies, and in supervising and managing the room as they supposed to manages messages for surgeon and first assistant, communicates procedural progress to the control desk and family members, this actions make them out of the room for several times and which in turn fail to plans and implements direct care using the nursing process, prevents inappropriate traffic through the room, documents procedural activities in patient record. The circulator nurse leaves the room for many reasons such as preparation for next case, interrupted tasks of formal and informal activities. Post implementation of lean management strategies these procedure were improved because the circulator nurses allotted more time in supervising the OR team in particular supporting scrub nurses especially those with short experience. In consistent to this finding, **Fekry & Ali, (2015)** reported that circulator nurses provided good nursing care for only 10% of patients.

The present study displayed that more than half of the circulator nurses did not meet standards in dispensing or transferring items to sterile surface as appropriate in the forms of opens wrappers and peel packs, opens closed container, dispensing solution and medication. Moreover, the circulator nurses did not meet standards in anticipating needs of patient, anesthesia provider, surgeon, and others team members in the form of

coordination with the scrub persons, obtains additional supplies and instrumentation as needed. Regarding the circulator role of the activation of surgical machinery and devices, inside the theatre such as electro surgery cables, suction, power cords, monitors, peripheral equipment, these actions were transferred to the surgical technologist as a part of implemented the strategies of lean management, but around one third of the nurses continued to do double check randomly especially in major surgeries and when surgical technologist get busy by other room or in emergent machinery situation.

This gap in the performance of the circulator nurses can be interpreted as they were more tasks oriented of scrub role rather than other roles that are achieved by them such as anesthesia nurse, PACU nurse, surgical technologist and instrumentation technicians, surgical aid, store keeper and so on. Therefore, the segregation of the scrub roles and circulator roles to a group of minor roles are important to eliminate the volume of un-value added roles. After implementation of lean management strategies, all supportive roles were implemented and functioned and reflected on the quality of the circulator nurses roles in the mentioned tasks by the majority of them with statistical significance difference, while focused training on playing circulator role still required for better accomplishment.

Regarding the gap in the performance standards of the circulator nurses at pre management of lean strategies, most of nurses did not meet standards in particular for validating implant parameters and documents in the lot log, report for duty in a punctual manner, accountability in the forms of gathers and checks solutions and drugs for use on the field, documents amount of

usage of drugs and solutions on the field, practices safety for the patient and team, monitors the sterile field and the members of the sterile team. In addition, more than half of the circulator nurses did not meet standards in practices of aseptic technique in the forms of dons/removes sterile or non-sterile gloves as appropriate for task, hand hygiene with hand antiseptic. After implementation of lean management strategies, improvement were achieved with statistical significance difference by the majority of the circulator nurses as they became totally freely responsible to implement these tasks during surgeries without delay and stay around the surgical field.

The present study displayed that more than half of the circulator nurses do not meet standards in providing safe and competent direct patient care in the forms of patient advocates, identification, teaching assessment, assists the anesthesia provider as needed during induction, validates correct site protocol and time out procedures, responds appropriately to emergent situations, supports psychological aspects of care, positioning patient and prepping as appropriate, monitoring physiologic and psychological responses as appropriate, cares for specimens. The non-compliance in these roles happens due to several reasons such as lack of knowledge and training, role ambiguity, overlaps of activities, high and rapid flow of surgical cases, lack of medication administration experience, and calculation of doses. The implementation of lean management strategies improved these roles especially for the activities that belong to the anesthesia nurses, because the four nurses with bachelor degree qualification were assigned for anesthesia roles only to properly maintain the safety of patients and the quality of care.

In consistent with the study of **Ding, et al., (2017)** the majority of the

circulator nurses did not meet standard to assists the anesthesia provider as needed during induction and to validates correct site protocol and time out procedures for the provision of safe and competent direct patient care. As practicing of the safety procedure checklist, it was noted that the checklist was commonly applied by circulator nurse. In line to the result of **Alaa-Eldeen, et al., (2012)** the nurses' level of safety practices of surgical procedure checklist was unsatisfactory in all the phases of surgery and the checklist was filled by circulator nurse instead of surgeons and anesthetists (**Abbasoglu, et al., 2016**).

In similar approach, the study of **Eriksson, Lindgren, Lindahl, (2020)** which aimed to examine nursing care experiences of new trained OR nurses', the results revealed the nurses' experienced gap between theory and practice, threatens of unsafe nursing when they lack time for patients as well as for themselves, they also lack feedback for improving care, nurses were task oriented instead of the patient as a person. The study also encouraged for new methods of organizing operating units work, and well-functioning teams. The perioperative team should have a shared governance goal that is the delivery of effective patient care provided in a safe, effectual, and timely fashion by the all members who should harmonize their efforts and contributes to prosperous outcomes of surgical procedures(**Phillips, 2017**).

According to current study result and before the implementation of lean management strategies, almost all the perioperative nurses were computer illiterate, later on, part of lean management strategies, computers were placed in each surgical room to help nurses to use patient electronic medical record and manage patient charges at the time of surgery without pending and vice versa facilitate

for the anesthesia nurses to communicate via the system with blood bank, Laboratory, PACU nurse, ward nurse, and ward clerk for all services needed for patients which improved the computer literacy for nurses with high statistical significance difference. Since lack of informatics skills considered common obstacle to embracing evidence-based practice and quality improvement (**Solomons & Spross, 2011**), therefore, basic competence on informatics is essential for developing perioperative nursing competencies as was advised by **Cronenwett, et al., (2007)**.

Finally, when the un-value added roles of OR nurses are eliminated and the volumes based roles are redesigned, additional responsibilities of value added roles are cross the threshold of the operating room nurses, to support and promote personal and professional development of perioperative nursing and contribute to the profession. These value added roles include, participate professionally informal and informal organizational activities; participates in research accomplishments; investigation and authentication of existing and upcoming practice, pursuit evidence to advance to best practice; participates in continuous educational sequencers to enrich personal and professional knowledge; certification to validate excellence in nursing practice; acts as a role model for nursing students and colleagues; mentor, percept, and instruct other perioperative nurses (**Goodman, Spry & Burlington, 2017**).

In Egypt until present, few hospitals are adopting quality management systems in healthcare and the members of the quality team are only formed from physicians without giving an opportunity for the quality nurse within this team. As long they are not nurses, they can't feel or think like a nurse, and they will not be able to apply effective systems to promote

nurses efficiency and accept them as a creative thinker not only workers, therefore, the lean management strategies focused on redesigning the roles of scrub and circulator nurses, in addition to developing of new supportive roles assigned in OR to improve the quality of the perioperative nursing which will be reflected on the safety and quality of patient outcome.

Study Limitations:

Performance observation of anesthesia nurses role was not established alongside the study because the role was not applicable before the implementation of the lean management strategies.

Table (1) Demographic Characteristics of the Study Sample (n=32)

Items	N0. (%)
Age	
<25 years	10 (31.3)
26-35years	17(53.1)
36-45years	3 (9.4)
> 46years	2 (6.2)
Gender	
Female	27 (84.4)
Male	5 (15.6)
Marital Status	
Married	19 (59.4)
Single	13 (40.6)
Qualification	
Diploma nursing school	16 (50.0)
Technical health institute	12 (37.5)
Bachelor degree	4 (12.5)
Years of Experiencein OR	
< 5 years	10 (31.3)
6-10	12 (37.5)
11-15	8 (25)
16-20	2 (6.2)
Prior Training in OR	
Yes	10 (31.3)
None	22 (68.7)
Source of up-to-date information	
Nurse mate	23 (71.9)
Surgeons	5(15.7)
Anesthetist.	1 (3.1)
Company vendor	1 (3.1)
Head nurse/supervisor	2 (6.2)

Table (2): Performance Observation of Scrub Nurse Roles Pre and Post Lean Management Strategies(N=32).

Scrub Roles items	Pre Lean Manage. Strategies		Post Lean Manage. Strategies		X ² test	
	Meet N0. (%)	Not Meet N0. (%)	Meet N0. (%)	Not Meet N0. (%)	X ²	P
Report for duty in a punctual manner.	7 (53.1%)	25 (78.1%)	23 (71.8%)	9 (28.2%)	16.1	0.00**
Wears OR attire properly:	16	16	28	4	10.5	0.00**

Dons personal protective gear/Dons radiation badge as needed	(50.0%)	(50.0%)	(87.5%)	(12.5%)		
Performs housekeeping duties:						
Before first procedure of day/Between procedures/After procedure of day.	14 (43.8%)	18 (56.3%)	11 (34.4%)	21 (65.6%)	0.6	0.44
Sterile supplies:						
Plans and gather supplies/Checks integrity of packages/Sterility integrator/Dates on perishables.	21 (65.6%)	11 (34.4%)	26 (81.3%)	6 (18.7%)	2.0	0.15
Places items on sterile surface:						
Opening wrappers/Peel packages/Solution dispensing.	26 (81.3%)	6 (18.8%)	27 (84.4%)	5 (15.6%)	0.1	0.74
Scrubs for setup and procedure:						
Hand and arm scrubbing/Hand hygiene with hand antiseptic.	27 (84.4%)	5 (15.6%)	28 (87.5%)	4 (12.5%)	0.1	0.71
Gowning:						
Gowns self correctly/Gown others.	28 (87.5%)	4 (12.5%)	30 (93.7%)	2 (6.3%)	0.7	0.39
Gloving:						
Closed and opens methods/Changes contaminated glove/Gloves others.	24 (75.0%)	8 (25.0%)	25 (78.2%)	7 (21.8%)	0.1	0.76
Sterile setup:						
Drapes tables and mayo stand/Position items in the field.	28 (87.5%)	4 (12.5%)	32 (100%)	0 (0.0%)	4.3	0.03*
Accountability:						
Participates in safety timeout before incision/Labels solutions and drugs/Reports amount of use/Maintains the sterile field/Responds appropriately to emergent situations.	15 (46.9%)	17 (53.1%)	19 (59.4%)	13 (40.6%)	1.0	0.31
Anticipates needs of surgeons:						
Coordinates with circulator/Facilitates the first assistant/Passes instrumentation/Prepares and applies dressing materials.	7 (53.1%)	15 (46.9%)	22 (68.7%)	10 (31.3%)	1.6	0.20
Counts:						
Sponges/Sharps/Instruments.	18 (56.3%)	14 (43.8%)	32 (100%)	0 (0.0%)	17.9	0.00**
Assembles instruments:						
Attaches knife blades on handles/Loads or prepares sutures/Tests drills and devices.	24 (75.0%)	8 (25.0%)	27 (84.4%)	5 (15.6%)	0.9	0.35
Disassembles the tables:						
Follows proper disposal of items/Decontamination procedures.	22 (68.8%)	10 (31.3%)	32 (100%)	0 (0.0%)	11.9	0.00**
Removes gown and gloves:						
Gown off first/Glove-to-glove/skin-to-skin.	23 (71.9%)	9 (28.1%)	24 (75%)	8 (25%)	0.1	0.77
Total	17 (53.1%)	15 (46.9%)	25 (78.1%)	7 (21.9%)	4.4	0.03*

* Statistical significance difference at $P < 0.005$ * * High Statistical significance difference at $P = 0.000$

Table (3): Performance Observation of Circulator Nurses Roles Pre and Post Lean Management Strategies (N=32).

Performance Role Statements	Pre Lean Manage. Strategies		Post Lean Manage. Strategies		X ² test	
	Meet N0. (%)	Not Meet N0. (%)	Meet N0. (%)	Not Meet N0. (%)	X ²	P
Report for duty in a punctual manner:	8 (25.0%)	24 (75.0%)	22 (68.7%)	10 (31.3%)	12.3	0.00**

Wears OR attire properly:	16 (50.0%)	16 (50.0%)	20 (62.5%)	12 (37.5%)	1.0	0.31
Performs housekeeping duties:	11 (34.4%)	21 (65.6%)	26 (81.3%)	6 (18.7%)	14.4	0.00**
Sterile supplies:	19 (59.4%)	13 (40.6%)	24 (75.0%)	8 (25.0%)	1.8	0.18
Dispenses or transfers items to sterile surface as appropriate: Opening wrappers/Peel packages/Dispensing solutions & medications.	4 (12.5%)	28 (87.5%)	21 (65.6%)	11 (34.4%)	19.0	0.00**
Validate implant parameters and documents in the lot log.	7 (21.9%)	25 (78.1%)	30 (93.7%)	2 (1.3%)	33.9	0.00**
Practices aseptic technique:						
Dons and removes sterile or non-sterile gloves as appropriate for task/ Hand hygiene with hand antiseptic.	10 (31.3%)	22 (68.8%)	27 (84.4%)	5 (15.6%)	18.5	0.00**
Gowning and gloving of others:						
Ties gowns for sterile team members/Assist with contaminated glove removal/Provides additional gowns and gloves as needed.	25 (78.1%)	7 (21.9%)	28 (87.5%)	4 (12.5%)	1.0	0.32
Accountability:						
Gathers and checks solutions and drugs for use on the field/ Documents amount of usage of drugs and solutions on the field/ Practices safety for the patient and team/ Monitors the sterile field and the members of the sterile team.	9 (28.1%)	23 (71.9%)	30 (93.7%)	2 (1.3%)	28.9	0.00**
Anticipates needs of patient, anesthesia provider, surgeon, and others team members:						
Coordinates with the scrub person/ Obtains additional supplies and instrumentation as needed.	14 (43.8%)	18 (56.3%)	18 (56.3%)	14 (43.7%)	1.0	0.31
Provides safe and competent direct patient care:						
Advocates/Identification/Assessment of Patient/Assists the anesthesia provider as needed during induction/ Validates correct site protocol and time out procedures/Responds appropriately to emergent situations/ Positioning and prepping /Monitoring physiologic and psychologic responses /Cares for specimens.	9 (28.1%)	23 (71.9%)	15 (46.8%)	17 (53.2%)	2.4	0.12
Counts:						
Sponges/Sharps/Instruments/ Documents any other item added to the field intra-operatively.	16 (50.0%)	16 (50.0%)	21 (65.6%)	11 (34.4%)	1.6	0.20
Attaches and activates surgical machinery and devices for the sterile field:						
Electrosurgery cables, suction, power cords, and other peripheral equipment/ Activates, set, and monitor peripheral equipment.	12 (37.5%)	20 (62.5%)	13 (40.6%)	19 (59.4%)	0.1	0.79
Supervise and manages the room:						
Manages messages for the surgeon and first assistant/Communicates procedural progress to the control desk and with family members/Prevents inappropriate traffic through the room/Documents procedural activities in patient record.	18 (56.3%)	14 (43.8%)	23 (71.9%)	9 (28.1%)	1.7	0.19
Computer literacy:						
Uses patient electronic medical record responsibly/Manages patient charge items responsibly.	3 (9.4%)	29 (90.6%)	16 (50.0%)	16 (50.0%)	12.7	0.00**
Total	6 (18.7%)	26 (81.3%)	19 (59.4%)	13 (40.6%)	11.1	0.00**

* Statistical significance difference at P< 0.005

** High Statistical significance difference at P= 0.000

Figure (1): Total Performance Observation of Scrub Nurses Roles (N=32).

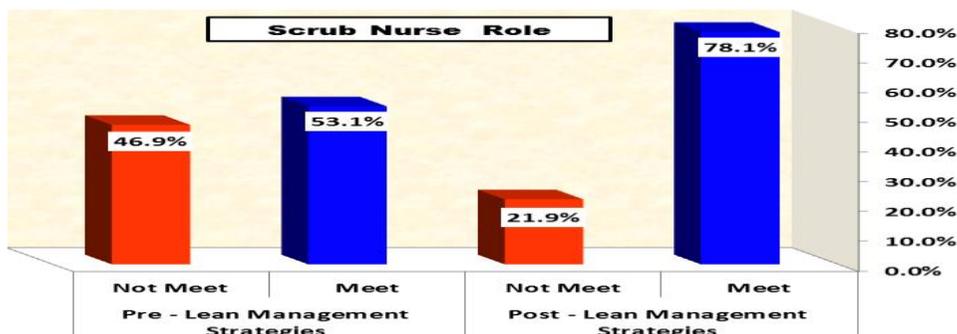
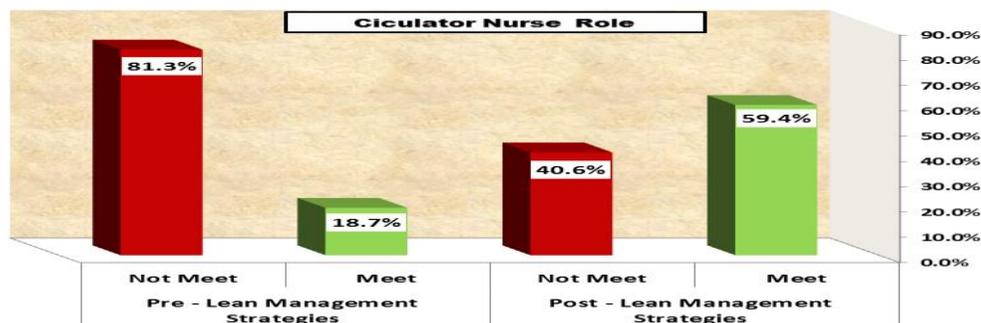


Figure (2): Total Performance Observation of Circulator Nurses Role (N=32).



Conclusion

Based on the assessment of the scrub and circulator nurses roles, before the implementation of lean management strategies, the performance standards gaps were identified in the form of indirect patient care activities which were fulfilled by other supportive OR personnel. Positive effect with significant improvement in the performance of perioperative nursing roles was produced as a result of implemented lean management strategies.

Recommendations

In the light of the study results, it was recommended to;

- Perform periodical assessment for the perioperative nursing performance related to non-clinical and clinical process to achieve optimal quality and safety delivered for patient care.
- Provide continuous training and scientific updates for perioperative nursing and OR supportive staff.
- Future studies are required for using the lean management strategies to increase the effectiveness of operating room utilization such as reduction of wasted time and increase the flow of surgical cases.
- Lean management strategies can be broadly used to eliminate the prolonged length of patient hospital stay, or prolonged waiting time in out-patient clinic or emergency room.

▪ Operating room administrators should continuously assess the performance gaps.

▪ Apply lean management strategies and investigate its effect on the perioperative nursing in different settings.

Conflicts of interest disclosure

The authors declare they have no conflicts of interests.

Financial support

- No funding was received

References

- Abbasoglu A., Ugurlu Z., Isik S., Karahan A., Unlu H., & Elbas N. (2016): The status of use of surgical safety checks list and opinions of nurses. *J Res Dev Nurs*. 18(1):53-62.
- Adriana C., & Sarmiento C. (2015): Evaluation of adherence to measures for the prevention of surgical site infections by the surgical team, *Rev Esc Enferm USP* · 49(5):764-770.
- Aiken, L., Sloane, D., Bruyneel, L., Van den Heede, K., Griffiths, P., Busse, R., & Lesaffre, E. (2014): Nurse staffing and education and hospital mortality in nine European countries: A retrospective observational study. *The Lancet*, 383(9931), 1824–1830.
- Alaa-Eldeen T., Saad A., & Elrefaee N. (2012): Assessment of nurses' practices related to safety of intraoperative surgical patient undergoing general anesthesia. *Journal of American Science*; 8(8):118-130. <http://www.jofamericanscience.org>
- Andersson, A., Bergh, I., Karlsson, J., Eriksson, B., & Nilsson, K. (2012): Traffic flow in the operating room: An explorative and descriptive study on air quality during orthopedic trauma implants surgery. *American Journal of Infection Control*, 40(8): 750–755. <https://doi.org/10.1016/j.ajic.09.015>
- Awadalla, G., Garas A., & Hanafy N. (2019): Compliance with Standard Precautions among Operating Room Nurses at a University Hospital, Egypt. *American Journal of Biomedical Science and Research*, 272-276. www.biomedgrid.com
- Belowska J., Panczyk M., & Gotlib J. (2014): Comparison of knowledge and attitudes towards the use of scientific research in clinical practice among departmental and charge nurses. *Polish Journal of Public Health*, 124:138-144.
- Blomberg, A., Bisholt, B., & Lindwall, L. (2018): Responsibility for patient care in perioperative practice. *Nursing Open*, 5(3), 414–421. <https://doi.org/10.1002/nop2.153>.
- Blomberg, A., Bisholt, B., Nilsson, J., & Lindwall, L. (2015): Making the invisible visible—operating theatre nurses' perceptions of caring in perioperative practice. *Scandinavian Journal of Caring Sciences*, 29(2), 361–368. <https://doi.org/10.1111/scs.12172>.
- Blomberg, A., Lindwall L., & Bisholt B. (2019): Operating theatre nurses' self-reported clinical competence in perioperative nursing: A mixed method study. *Nursing Open*. 6:1510–1518. wileyonlinelibrary.com/journal/nop2.
- Candas, B., Bulut, E., Çilingir, D., Gürsoy, A., Erturk, M., & Aydın, A. (2017): Surgical Count Implementations in the Operating Rooms: An Example from Turkey, *Journal of Surgery [Jurnalul de Chirurgie]* 13(2): 55-58. ISSN: 1584-DOI: 10.7438/1584-9341-13-2-2
- Cawich, O., Ingrid A., Clarence D., Hyacinth H., Christine A., & Ivor W. (2013): Infection Control Practice in the Operating Room: Staff Adherence to Existing Policies in a Developing Country; 17(3):e114-118.
- Collins, L., Dziak, J., Kugler, K., & Trail, J. (2014): Factorial experiments: efficient tools for evaluation of intervention components. *Am. J. Prev. Med.*, 47 (4), 498-504. <http://dx.doi.org/10.1016/j.amepre.2014.06.021>.
- Crafoord, M., & Fagerdahl, A. (2017): Clinical supervision in perioperativenursing education in Sweden – A questionnaire study. *Nurse Education in Practice*, 24, 29–33. <https://doi.org/10.1016/j.nepr.03.006>

- Cronenwett, L., Sherwood, G., Barnsteiner, J., Disch, J., Johnson, J., Mitchell, P., Warren, J. (2007): Quality and safety education for nurses. *Nursing Outlook*, 55(3), 122-131. <https://doi.org/10.1016/j.outlook.02.006>.
- Ding, S, Lin, F, Marshall, A., & Gillespie, B. (2017): Nurses' practice in preventing postoperative wound infections: an observational study. *Journal of Wound Care*, 26(1):28-37.
- El-Kady, R. (2010): Factors influencing nurses' performance for patients undergoing bronchoscopy. Unpublished master theses. Alexandria University, Faculty of Nursing.
- El-Sayed Z., Gomaa A., & Abdel-Aziz M. (2015): Nurses' knowledge and practice for prevention of infection in burn unit at a university hospital: Suggested nursing guidelines. *IOSR Journal of Nursing and Health Science*, 4(4):62-69.
- Eriksson, J., Lindgren, B., & Lindahl, E. (2020): Newly trained operating room nurses' experiences of nursing care in the operating room. *Scandinavian journal of caring sciences*.
- Famakinwa T., Bello B., Oyeniran Y., Okhiah O., & Nwadike R. (2014): Knowledge and practice of post-operative wound infection prevention among nurses in the surgical unit of a teaching hospital in Nigeria. *International Journal of Basic, Applied and Innovative Research*, 3(1):23-28.
- Fekry N., & Ali R. (2015): Nurses performance at operating room at El- Minia University Hospital, *Med. J. Cairo Univ.*, 83(1), 409-416. Available at <https://www.mjcu.journals.ekb.eg/>
- Geedey, N. (2015): Lean and Six Sigma Impact on Operating Room Safety Attitudes and Efficiency. *Nursing Theses and Capstone Projects* 198. https://digitalcommons.gardner-webb.edu/nursing_etd/198.
- Gillespie, B., Marshall A., Lavin J., Gardiner T., & Withers T. (2016): Impact of workflow on the use of the surgical safety checklist: A qualitative study. *ANZ J Surg*:86(11);864-867. doi:10.1111/ans.13433.
- Goodman, T., Spry, C., & Burlington, M. (2017): *Essentials of perioperative nursing*. Jones and Barlett. ISBN-13: 978-1284079821. *Crit Care Nurse*, pp. 1-12.
- Hakim, S., Abouelezz N., & El-Okda E. (2016): Use of personal protective devices among health care workers in a teaching hospital in Cairo, Egypt *Egyptian Journal of Occupational Medicine*, 40 (2) : 287-300.
- Hassanain, M., Zamakhshary M., Farhat G., & Al-Badr A. (2017): Use of Lean methodology to improve operating room efficiency in hospitals across the Kingdom of Saudi Arabia, the international journal of health planning and management. V 32, 133-146. DOI: 10.1002/hpm.2334
- Jones A., & Johnstone M. (2018): Managing gaps in the continuity of nursing care to enhance patient safety, *Collegian* 26:151-157. www.elsevier.com/locate/coll.
- Kelvered, M., Ohlen, J., & Gustafsson, B. (2012): Operating theatre nurses' experience of patient-related, intraoperative nursing care. *Scandinavian Journal of Caring Sciences*, 26(3), 449-457. <https://doi.org/10.1111/j.1471-6712.2011.00947.x>.
- Kisacik O., & Cigerci Y. (2019): Use of the surgical safety checklist in the operating room: Operating room nurses' perspectives. *Pak J Med Sci*. Vol. 35 No. 3 www.pjms.org.pk
- Lohiniva, A., Bassim, H., Hafez, S., Kamel, E., Elkoraie, A., Saeed, T., & Talaat, M. (2015): Determinants of hand hygiene compliance in Egypt: Building blocks for a communication strategy *Eastern Mediterranean Health Journal*. V 21, 665-670.
- Mitchell L., Flin R., Yule, S., Mitchell, J., Coutts, K., & Youngson G. (2011): Thinking ahead of the surgeon: An interview study to identify scrub nurses non-technical skills. *International Journal of Nursing Studies*. 48, 818-828. doi:10.1016/j.ijnurstu.11.005.
- NSW Agency for Clinical Innovation (ACI) (2014): *Operating theatre efficiency guidelines: A guide to the efficient management of operating theatres in New South Wales hospitals*. ACI: Chatswood NSW; 1-82.
- Phillips, N. (2017): *Berry & Kohn's Operating Room Technique*, 13th Edition, St. Louis, Missouri, Elsevier Publisher,

- ISBN: 9780323399265. Available at <https://leen.loc.gov/2016000371> and retrieved on January 2019.
- Qasem M., & Hweidi I. (2017): Jordanian nurses' knowledge of preventing surgical site infections in acute care settings. *Open Journal of Nursing*, 7(5):561-582.
- Rothrock, J. (2015): *Alexander's Care of the Patient in Surgery 15th Edition*, San Louis, Elsevier, Mosby. <https://books.google.com.eg/books>
- Sabbour, S., Ez-Elarab, H., and Salah El-din W., & Hitham A. (2015): Compliance of health care providers with perioperative patient safety guidelines in a general hospital in Cairo. *The Egyptian Journal of Community Medicine* Vol. 33 No. 3.
- Sandelin, A., & Gustafsson, B. (2015): Operating theatre nurses' experiences of teamwork for safe surgery. *Nordic Journal of Nursing Research*, 179-185, <https://doi.org/10.1177/0107408315591337>.
- Schweikhart, S., & Dembe A. (2009): The applicability of Lean and Six Sigma techniques to clinical and translational research. *J Invest Med*; 57:748-755.
- Smith, J., & Palesy, D. (2018): Technology stress in perioperative nursing: An ongoing concern. *ACORN*, 31(2), 25-28.
- Solomons, N., & Spross, J. (2011): Evidence-based practice barriers and facilitators from a continuous quality improvement perspective: An integrative review. *Journal of Nursing Management*, 19(1), 109-120. <https://doi.org/10.1111/j.1365-2834.01144.x>.
- Spruce, L. (2015): Back to basics: Implementing evidence-based practice. *AORN Journal*, 101(1), 106-112; quiz 113-114.e104. <https://doi.org/10.1016/j.aorn.08.009>
- Stelman, V., Graling, P., & Perkhounkova, Y. (2013): Priority patient safety issues identified by perioperative nurses. *AORN Journal*, 97(4), 402-418. <https://doi.org/10.1016/j.aorn.06.016>
- Stoutzenberger, L. (2014): Using Lean strategies to improve operating room efficiency, Access Intelligence. 888/707-5814. www.ormanager.com.
- Swedish Institute of Standards (2019): Swedish standard SS-EN ISO 16054, Implants for surgery - Minimum data sets for surgical implants (EN ISO 16054:200). www.sis.se
- Teshager F., Engeda E., & Worku W. (2015): Knowledge, practice, and associated factors towards prevention of surgical site infection among nurses working in Amhara Regional State Referral Hospitals, Northwest Ethiopia. *Surgery Research and Practice*, 1-6.
- Thompson, D. (2019): From Central Africa to Egypt: A Surgeon's Journey. *Christian Journal for Global Health* 6(2):50-54. <https://doi.org/10.15566/cjgh.v6i2.28>.
- Toussaint, J., & Berry L. (2013): The Promise of Lean in Health Care. *Mayo Clin Proc.*; 88(1):74-82.
- Westra, B., & Peterson, J., (2016): Big data and perioperative nursing. *AORN Journal*, 104(4), 286-292. <https://doi.org/10.1016/j.aorn.07.009>.
- Wistrand, C., Falk-Brynhildse, K., and Nilsson, U. (2017): National survey of operating room nurses aseptic techniques and interventions for patient preparation to reduce surgical site infections. *Surg Infect (Larchmt)* 19(4):438-445. DOI: 10.1089/sur.2017.286.