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The Impact of Training of Operating Theatre Nurses on the Clinical Competence or Identified Technical Skills: Systematic Review

Ali Al Alwi[1,2*], Eman Al Ali[2,3], Layla Al Turki[4,5], Taiba Khoder[6,7], Janan Kkudhar[8,9], Fatimah Almajhad[1,10], Sarah Alhejji[1,10], Mohammad Alnasser[11,12], Ahmed Alshaghab[11,13], Ahmed Alfayez[12,14], Hassan Almohana[10,15], Fatimah Aljasim[1,16], Samirah Al Muhainy[1,17], Ali Boweis[10,18], Saleh Albattat[3,17], Majed Al Eissa[3,16], Ishaq Al Ghazal[3,16], Mustafa Khudhar[4,19], Adnan Al Khamais[1,16], Moayad Alabbad[14,20], Thanaa Alethan[3,16], Rasha Nazer[1,21], Hajar Al Braih[1,5], Ali Busbaih[21,22], Eman Alawad[10,15], Nasser Almukainah[23,24], Mariam Alluwaif[8,25], Ahmed Almohammedali[1,26]

[1]Prince Saud Bin Jalawi Hospital, Alhassa, Saudi Arabia
[2]Newcastle University, Newcastle, Australia
[3]Primary Health Care Centre, Alhassa, Saudi Arabia
[4]Dammam Medical Complex, Dammam, Saudi Arabia
[5]Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
[6]Ras Tanurah Hospital, Ras Tanurah, Saudi Arabia
[7]College of Health Sciences, Dammam, Saudi Arabia
[8]Al Qatif Center Hospital, Al Qatif, Saudi Arabia
[9]Shaqra University, Shaqra, Saudi Arabia
[10]Hajar Health Sciences Institute Alhassa, Saudi Arabia
[11]Ministry of Health, Alhassa, Saudi Arabia
[12]King Saud University, Riyadh, Saudi Arabia
[13]International Academic for Sciences Institute, Alhassa, Saudi Arabia
[14]Psychiatric Hospital, Alhassa, Saudi Arabia
[15]Maternity and Children Hospital, Alhassa, Saudi Arabia
[16]College of Health Sciences, Alhassa, Saudi Arabia
[17]Health Sciences Institute, Alhassa, Saudi Arabia
[18]Department of Ambulance Transportation, Alhassa, Saudi Arabia
[19]Department of Advanced Medical Imaging, University of Cincinnati, Cincinnati, USA
[20]Arab Development Institute, Dammam, Saudi Arabia
[21]College of Health Sciences, Altief, Saudi Arabia
[22]General Dentistry Department, King Fisal Hospital, Alhassa, Saudi Arabia
[23]King Fahad Hospital, Alhassa, Saudi Arabia
[24]Dental Technology Department, Specialist Academy for Medical Training, Riyadh, Saudi Arabia
[25]Dammam Academic Institute, Dammam, Saudi Arabia
[26]Orthopaedics Department, New South Walas University, Sydney, Australia
Email: *ahalalwi@moh.gov.sa

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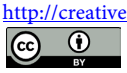

Abstract

Background: Technical skills play an integral part in perioperative nurse work in preventing adverse outcome in operating rooms (OR). Pervasive critical shortage of skills and evolution of technologies has pushed for integration of different approaches to training to address the deficit in technical skills. **Objective:** The aim is to investigate the impact of training in technical skills on operating theatre nurses' clinical competence and describe important factors of clinical competence for operating theatre nurses (OTNs). **Method:** We used systematic review of the evidences on the best practice in design and delivery of training for operating theatre nurses. The review systematically searched for six relevant articles in PubMed, CINAHL and Embase using keywords and mesh terms for studies on training of perioperative nurses in December 2024. We extracted information on training and the impact of training on participant's technical skills. **Results:** The systematic review screened 518 sources from the three identified databases where six peer-reviewed sources met the inclusion criteria developed by the authors and were included for analysis. The authors used the Cochrane Risk of Bias tool to assess the level of empirical evidence based on five domains of bias. **Finding:** Our findings demonstrate that simulation and technology-based approaches significantly improve nurses' technical skills and confidence. **Conclusion:** The review underscores the importance of structured and technology-driven training programs in enhancing operating room (OR) nurses' technical skills. The lack of standardized training approaches and limited research on long-term outcome indicates a need for further studies to optimize training designs and delivery methods for operating room nurses.

Keywords

Training, Operating Theatre, Technical Skills, Education

1. Introduction

Perioperative nursing is a specialty that focuses on holistic caring relationship for the health and healing of patients undergoing invasive procedure or operations, starting from patient assessment, to intraoperative practice to recovery period [1]. Notably, working with surgical patients requires a knowledge base beyond the basic nursing training, where technical skills based on understanding of surgical anatomy, use of anaesthesia, related changes in human body during procedures, the risk factors and prevention of injury to patients are a prerequisite [2]. The nurse should be apt with anticipation of the needs of the team and the patient using critical thinking for rapid use of safety interventions when working within dynamic integrated perioperative teams.

Technical skills are salient attributes of an effective and efficient perioperative nurse's portfolio and essential to safety for working in operating room (OR).

Specifically, it is noticeable that high-tech operating room presents opportunities for operating room nurses who have from time to time required continuous development of clinical competence in perioperative nursing, to hone their technical skills [3]. It is noted that technical skills; including proficiency in using and maintaining surgical equipment and understanding surgical procedures, are pre-requisite for success of nurses in perioperative practice [4] [5]. There is a need to continually assess operating theatre nurses' competence in light of the uniqueness of the perioperative situations, where the theatre nurses are in their best element in delivery of quality and safe nursing care, from the start to the end of the surgery.

Previous reviews have focused on acceptability of new technologies, team training and non-technical skills [6]-[8] and have largely ignored studies that focus on enhancing technical skills for nursing staff or have included other major disciplines in surgery. To establish the current state of operating theatre nurse training, this review aims to document key aspects of theatre nurse in-service training such duration of training by assessing whether cross-trained perioperative nurses have the requisite technical skills to effectively assess, diagnose, plan, intervene, and evaluate the outcomes of nursing interventions in the operation theatre environment. Therefore, the review question was designed as follows: *what is the impact of cross-training of perioperative nurses on their technical skills*?

2. Methods and Materials

2.1. Search Strategy

The systematic review was developed based on the 2020 Joana Briggs Institute PRISMA checklist to identify and synthesize evidence on the impact of cross-training on nurses' technical skills and competencies [9]. We started with a broad search strategy in an iterative process that involved searching for studies on PubMed and general Google search for keyword and index texts that guided the development of a search strategy to be adopted for different databases. The search terms were included (keywords and index terms) in PubMed, CINAHL and Embase databases using the PICO tool.

Intervention

- Theatre training OR cross training OR perioperative training OR theatre nurse training OR professional development.

Population

- Cross trained nurse OR preoperative nurse OR operating room nurse OR surgical nurse OR theatre nurse OR anaesthesia nurse.

Outcome

- Technical skill OR Nurse outcome OR competen* OR Clinical OR skills.

The search strategy was as follows; (with strings and index terms) from the initial search combined using the Boolean operator "AND"):

Operating theatre OR perioperative nurse training OR cross training of nurses AND operating theatre nurse competence OR nurse skill OR technical nursing skills.

2.2. Inclusion and Exclusion Criteria

The authors aimed to capture the full spectrum of quality empirical studies that investigate the impact of cross-training on nursing outcome and technical skills in OR department.

1) Studies were excluded if they were conducted outside the OR department. The review was not restricted to any other department or care setting.

2) Studies that did not collect empirical data, such as literature reviews and editorial letters, were excluded. However, published peer-reviewed studies with qualitative and quantitative design and mixed method approach were included.

3) Studies written in English were included in this review; the studies were about the impact of cross training on nurse competencies and described one or more outcome measure related to nurse competency. This means that a study that valuated the effectiveness of perioperative training but did not include outcome measure was excluded because it does not justify the impact of cross training on the nursing staff.

4) Studies were excluded that did not include OR training intervention for the OR department. For example, if a study aimed to improve team work, communication skills or perioperative situations (or related measure). Such studies were excluded.

5) Studies reporting on students as participants were excluded. For example, a study that reports on the impact of operating theatre training on student nurses as part of their nursing training, which has an effect on their skills and competencies were excluded. This is outside the scope of the review.

Further, how hospitals offered their training of staff was not a selection criterion. Given the variety of training modules, it is not possible to determine which works best.

2.3. Selection Process

Three authors collated and uploaded the identified titles into the Covidence software for managing and streaming systematic reviews for screening. A total of 518 studies were imported for screening and 18 duplicates were removed. Two authors screened the titles and abstracts of the references based on the eligibility criteria and from the 500 citations, 399 were deemed irrelevant. One reviewer resolved differences through consensus building. The authors then conducted full-text screening for 64 articles while assessing the eligibility, and in the process, 58 studies were further excluded based on the following reasons: Wrong setting (n = 6), No OT training (n = 8), Adult population (n = 1), Wrong comparator (n = 6), Wrong intervention (n = 1), Wrong study design (n = 6), No technical skills (n = 6), wrong adult population (n = 16), Wrong patient population (n = 1). This left us six citations for inclusion that are described in the review **Table 1**. The screening process is also summarized in the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram [9] (**Figure 1**).

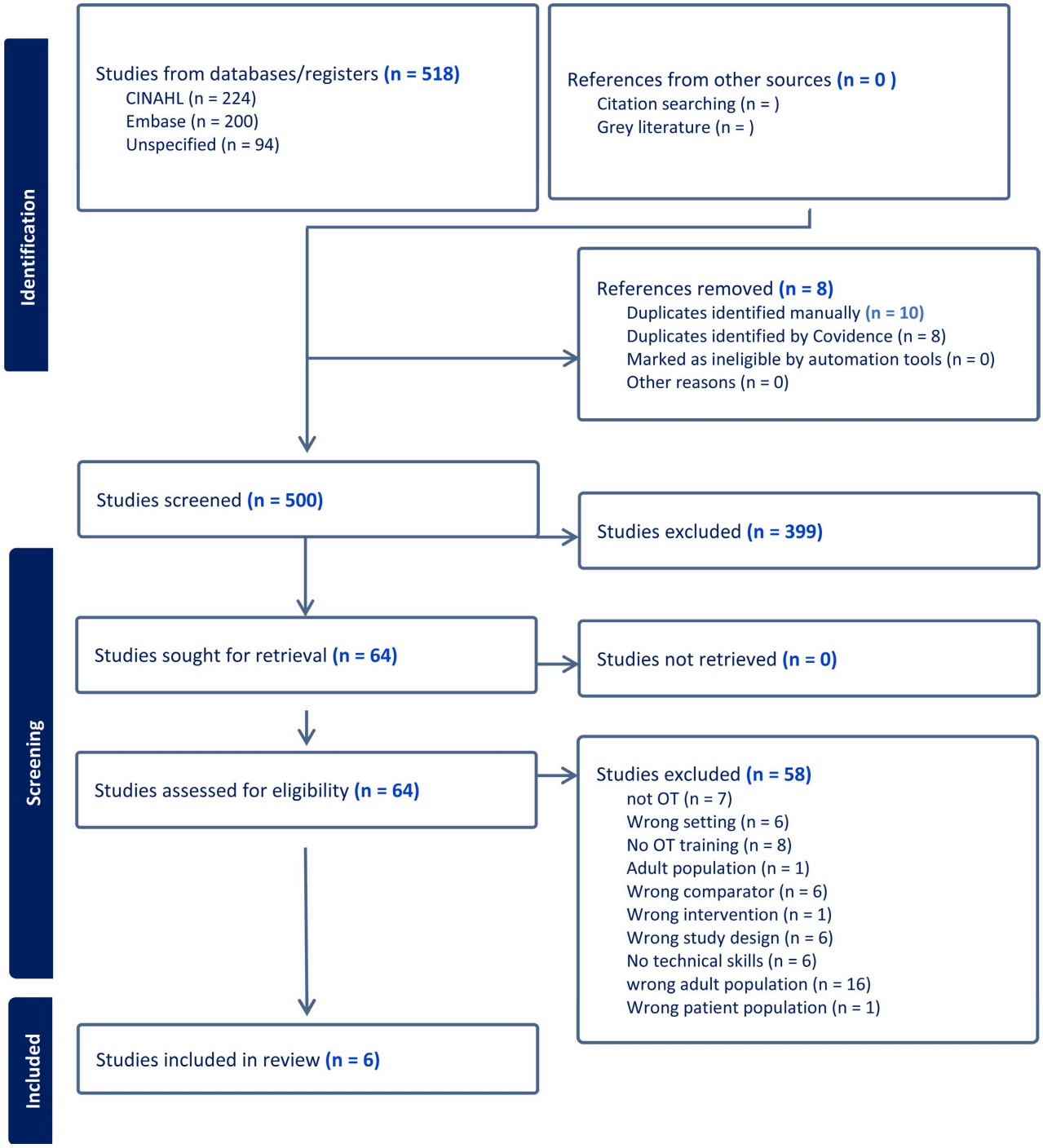

Figure 1. The PRISMA flow diagram displaying the screening process.

2.4. Data Charting/Extraction

The authors collectively developed a data charting form to compile information from each selected reference. The articles were charted in the form with the following structure; author, country, study design, setting (where the intervention happens), outcome measure, and important findings. This is displayed in the evidence table below (Table 1).

Table 1. Review table summarizing the characteristics of the included studies.

Author & Year	*Country*	*Setting*	*Methods: Design*	*Population: Inclusion criteria*	*Sample size*	*Intervention*	*Outcome measure*	*Training method*	*Training duration*	*Findings*
Jette Led Sørensen, 2015	Denmark	Department of Obstetrics and the Department of Anaesthesiology	Randomized controlled trial	trainee doctors in obstetrics and anaesthesiology, midwives, specialised midwives, auxiliary nurses, nurse anaesthetists and operating theatre nurses	19	management of an emergency caesarean section after a cord prolapse; and (2) a postpartum haemorrhage including surgical procedures for evacuaton of the uterus	40 item multiple choice questions	simulation-based medical education in the delivery room and operating theatre	2 months	There was no difference in mean post-MCQ scores between the ISS versus the OSS group adjusted for the pre-MCQ scores
Miller *et al.*, 2020	UK	operating theater	quasi-experimental with pre and post groups	operating theatre nurses	19	*IN-SITU* SIMULATION PROGRAMME IMPROVED TEAM PREPAREDNESS FOR AIRWAY EMERGENCIES anaphylaxis and laryngospasm	Pre- and post intervention questionnaires on confidence level and perceived emergency preparedness	Case-based simulation scenarios and practical skills	45-minutes training session on anaphylaxis and laryngospasm three months apart	educational interventions were successful with improved levels of confidence reported and all participants demonstrating the practical skills required to help manage the emergencies
Tao 2024	China	operating theater	A comparative observational study with a quasi-experimental design	new nurses	Study group 32 and control group 29 (n = 61)	a variety of newer training methods	test paper score, surgical notes evaluation and open-ended questions assessment	The control group (traditional training), the study group (an innovative and diversified training mode)	3 years	The study group, exposed to the innovative teaching approach, demonstrated significantly higher scores in both theoretical and practical examinations for technical skills compared to the control group ($p < 0.05$). Moreover, the study group exhibited a notable reduction in the connection time between operating tables, fostering improved coordination of practical skills in OR
Tamminen-Peter, 2019	Finland	operating theater	Case-control study	OT nurse	18	risk assessments in the acute care hospita	The nurses evaluated the benefit of the online studies with a	E-learning and practical training	8 hours, 4 hours in an OR and 4 hours in	Based on the evaluation results and oral feed-back the perioperative Card scheme

							five-Likert scale from 1 (=not beneficial) to 5 (=very useful)		the training room	consists of the same four parts: 1) E-learning 2) Practical training of evidence-based principles of patient handling 3) Application of skills at one's own workplace, and 4) Revision and demonstration of practical skills
Chen *et al.* 2024	China	operating theater	quasi-experimental with pre and post groups	a nurse qualification certificate; (2) have worked in the OR within 3 years; (3) have engaged in clinical nursing work; and (4) have an understanding or familiarity with laparoscopic procedures, techniques, or principles	78	a laparoscopic simulation training course in 6 consecutive weeks	The scores of operating room nurses, medical postgraduates and residents after completing the training courses were significantly higher than the initial performance	a virtual surgical simulation system	6 weeks	After laparoscopic simulation training, there was no statistically significant difference in the training course scores between the different groups. The surgical level scores before and after the training course for the operating room nurses, showed significant increase ($p < 0.05$).
Ali Nasiri Silab *et al.* 2024	China	Variety of settng including OR	Randomized controlled trial	qualified operating room nurses	62	Control group only received positioning recommendations; intervention group, received video-based surgical positioning training	pre-test checklist - post-test checklist on knowledge and practical skills related to correct surgical positioning	video-based surgical positioning training	1 month, at least 3 times a week	

3. Results

The studies were published between 2015 and 2024. Most of the studies were conducted in China (n = 3), with one each from Finland, the United Kingdom and Denmark. Two studies used Randomized control trial [10] [11], and three studies used a quasi-experimental study design with pre-test and post-test design [12]-[14] one was a case control study [15] to investigate the impact of operating theatre training on nurse's technical skills.

3.1. Participants

The study population for Miller included 32 newly employed OR nurses (less than four years of service) [13] while Tao included; 32 OR nurses with qualification

certificate in operating room [14]. The inclusion criteria used in Tao *et al.* stated that one must have worked in OR within 3 years, or have engaged in clinical nursing work for the intervention group or had and understanding or familiarity with laparoscopic procedures} in the intervention group [14]. The control group had 29 nurses who received traditional training. In Silab *et al.* 62 qualified operating room nurses (50 women, 12 men) participated in the study [10]. We included Sorensen *et al.* whose participants included trainee doctors in obstetrics and anaesthesiologist, midwives, specialized midwives, auxiliary nurse, nurse anaesthetists and operating theatre nurses (n = 100) [11]. This study was included in the review based on the fact that one of its primary aims was to assess OR nurse's competence in laparoscopic surgery where the nurses, unlike other team members, do not typically receive training in laparoscopic surgeries during their academic training. In the study, surgeons and anaesthesiologists provided a baseline for reference of nurses' technical skills.

3.2. Setting

Two studies happened in variety of settings [10] [15]. On the other hand, three studies were in single institutional programs or in the operating room [10] [11] [13]. Chen implemented the laparoscopic simulation training system in surgical subspecialties [12]. One study happened at the Department of Obstetrics and Department of Anaesthesiology for women and Reproduction Hospital and at the simulation centre for training [11]. Another one utilized *in situ* simulation-based training in OR and off-site training [13].

3.3. Duration of Training

One study used video-based training for one month, at least three times a week [10]. In Chen *et al.* the participants undertook a laparoscopic simulation training course for 6 weeks, with a structured session held weekly for a total of 12 hours of instruction [12]. In the study, participants also had two 40 minutes training sessions on laryngospasm and anaphylaxis for three months apart. On the other hand, Sorensen *et al.* simulation-based obstetric anaesthesia training *in situ* had 50 to 60 minutes debriefs and three phases of implementation (including; description, analysis and presentation) that included case-based, lecture-based and video based training in one day [11]. Longer training period was observed in one study where 32 newly employed nurses received OR nursing training from March of 2017 to March 2020 (three years) [14]. Further, the study by Tammine-Peter had training periods of 20 hours, 24 hours in an OR and 24 hours in the training room, spread over two separate years [15]. Lastly, there was two months training for simulation-based medical education in the delivery room and operating theatre [11].

3.4. New Technologies in OR Training

Three studies focused on the use of new technologies as a salient component of

OR training need for nurses [10]-[12]. Silab found that Video-based training (VBT), enhanced knowledge retention and led to adherence to surgical positioning standards among the 31 OR nurses and improved their safety protocols in the intervention group, with scores after the intervention improving significantly compared to control group ($p < 0.001$) [10]. In the *in situ* simulation study, there was no significant difference about the technical skills, patient safety attitude, and knowledge and stress measurements when compared to off-site simulation [11]. Similarly, Chen *et al.* found that there was no difference in mean post-MCQ scores between the ISS versus the OSS group adjusted for the pre-MCQ scores after laparoscopic simulation training [12]. In this study, the surgical level scores before and after the training course for the operating room nurses, showed significant increase ($p < 0.05$).

3.5. Virtual Reality Training in Use of Laparoscopic Training

Chen *et al.* underscored the use of laparoscopic assistance by less experienced individuals in operating theatre, especially operating room nurses [12]. This study evaluated the laparoscopic skills of 27 OR nurses, 31 clinical medical postgraduate students, and 16 residents before and after undergoing virtual reality training (included based on the fact that the study aimed to assess the competence of nurses in laparoscopic assistance). The participants were recruited to undertake a laparoscopic simulation training course in 6 consecutive weeks. In this study, it was apparent that Virtual reality training in use of Laparoscopic training was an invaluable resource to the participants' technical skills. Also notable was the fact that there was no statistically significant difference in the training course scores between the OR nurses and other OR team members. In this study, it is deduced that integration of virtual surgery simulation technology in surgical training of operating theatre nurses will effectively bridge the gap in technical skills and knowledge for OR nurses and other staff.

3.6. Use of Simulation

Two studies used simulation as a training approach to improve nursing staff technical skill in operating theatre [11] [13]. In one study, Sørensen *et al.* investigated the effect of *in situ* simulation (ISS) versus off-site simulation (OSS) on knowledge, patient safety attitude, stress, and motivation, perceptions of simulation, team performance and organizational impact [11]. Ten simulations were done where the mean number of minutes spent on caesarean section simulation ISS and OSS was 18 and 15 minutes. The analysis based on the 40 item multiple choice questions (MCQ test) gave similar results for the ten simulations, showing reliability of the training. There were no differences found in the ISS versus the OSS group though for the salivary cortisol STAI and CA the mean change from the baseline to the peak was similar. For the post hoc analysis, the STAI and the salivary cortisol levels increased in the respective groups after the first and second simulation. CA was found to have decreased from baseline to peak in the two group settings

in both the caesarean section and in the postpartum haemorrhage simulations. Equally, Miller *et al.* implemented cross-discipline *in-situ* simulation in readiness for airways emergencies. In this study, it was observed that overall training interventions were successful with nursing staff improving in their confidence to assist with APL valve and demonstrating practical skills in managing Anaphylaxis and laryngospasm.

3.7. New versus Traditional Teaching Approaches

One study investigated the training approaches for OR nurses to determine efficient approaches to development of technical skills. Tao was interested in new and diversified approaches to training and used quasi-experimental design to evaluate the impact on nurse technical skills [14]. The study group (n = 32) which experienced an innovative and diversified training mode over a 3-year period, demonstrated significantly higher scores in theoretical and practical tests than control group (n = 29 nurses) in operating theatre. Clearly, it can be deduced that newer training models enhances the technical skills and collaborative dynamic among new nurses for superior clinical performance and patient outcomes.

4. Discussion and Conclusions

This review sought to establish the impact of operating theatre training on perioperative nurse staff's technical skills. From the studies, it was apparent that new training models that incorporate the use of technology and simulation in training nurse staff were effective in development of nurse technical skills. From the appraised studies, it can also be deduced that there was significant improvement in the technical skills of the operating theatre nurses after undergoing the OR training. It was further seen that integration of technology into surgical training had numerous benefits which included shortening the learning curve associated with the technical skills for nursing staff which in turn enhanced the nurse's confidence [7]. Therefore, this study suggests that technology in OR training approaches can be incorporated into the induction program for novice OR nurses to improve their job competency. This is because effective nursing education optimizes the nursing practice and cultivates nurse competence to demonstrate professional quality or competence in the operating room.

Variety of training methods ranging from one-on-one training with instructor, simulation-led training, and case-based training to self-guided video-based practice have varied degrees of effectiveness in teaching technical skills and enhancing nurse competence. Our findings suggest that technical skills for OR nurses can be effectively acquired through simulation-based training and other technology-led training approaches, narrowing the bridge between clinical application and evidence-based practice. Typically, hands-on psychomotor technical skills training has been preferred as a gold standard training approach in perioperative settings, where novice nurses would receive mentorship and supervision as they develop their assisting skills. Studies have equally found significant difference in acquisition

of basic technical skill performance when traditional training is provided in comparison to use of novel training approaches [14] [16].

Given the description of the included studies, we raise a concern regarding patient safety and nursing outcomes being compromised when shorter training duration leads to inadequate comprehension of learned skills. Novice OR nurses could potentially benefit from hands-on and technology-led (e.g. case-based learning and simulations) training approaches over a period of time to effectively assist their teams in perioperative care for optimal patient care [16]. They can benefit from their foundational operating room training skills by using the long-term training sessions to refine their existing technical skills and knowledge to supplement the application of the learned skills during patient care.

4.1. Implications for Practice

Various cross-training approaches and professional development activities for perioperative nurses have varied degrees of success in terms of facilitating acquisition of technical skills. This review has identified the training needs of the nurses that align with incorporating newer training models for acquisition of technical skills, including the innovative and diversified approaches to training technical skills [14]. An effective clinical training system plays a crucial role in enhancing OR nurses' abilities, fostering organizational changes, positively influencing nursing practices and the status of nurses and instilling essential professional habits and safety culture [4]. Training in OR technical skills is just a first step to empowering nurses to practice to the extent of their practice and bridges formal learning with clinical practice.

We observe that although nurses are competent enough in their roles, the training durations were variable and could be inadequate in some situations given the complexities in the OR nursing roles. In one case, video-based training was offered for one month, at least three times a week [10] while one study had two 40 minutes training sessions on laryngospasm and anaphylaxis for three months apart. It remains to be seen the long term impact of this training on overall competence of the OR nurses given the immense role played by OR nurses in maximizing operational efficiency. There is need to prevent the disconnect between the training content and clinical necessities by bringing into perspective the specific technical skills needed by the OR nurses. Therefore, the supreme goal of training for OR nurse should be the amalgamation of perioperative nurses' clinical competence and we have to ascertain whether the training aids their technical skills over time.

4.2. Limitations

In this review, we limited our search to studies conducted within the operating room setting and those that included OR training intervention for the OR department and excluded studies that did not collect empirical data. Even with the use of a thorough and transparent selection of screening process in our paper, we had

a study that potentially included nursing staff and participants other than nursing staff (e.g. [11], inconsistent data collection method (e.g. limitations in validity and reliability of studies) and inconsistent quality appraisal which could, to some degree, affect our findings. Despite these limitations, we had studies with different study designs, and there was low risk of bias for the included randomized control studies making up for the limitations.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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