



Clinical Teaching of Residents in Operating Room: A Review of Methods and Strategies for Strengthening Teaching and Learning

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Abstract

Background: The operating room is considered a learning platform for technical and non-technical skill training. Training in operating rooms helps learners from different groups, especially surgery residents, acquire the necessary clinical competence. Nevertheless, operating room training is only effective if it is accompanied by efficient and applicable teaching methods.

Objectives: The current study aimed at reviewing the strategies and methods to enhance teaching and learning of residents in operating room settings.

Methods: The current review study was conducted based on library studies and review of the literature. PubMed, SID, and MagIran databases, as well as Google Scholar search engine, were searched using relevant phrases and keywords. A total of 60 articles were retrieved, out of which 22 articles were identified as consistent with the study objectives.

Results: The data obtained from the literature review were categorized into three sections: "General structure of training in the operating room", "strategies and methods to strengthen teaching and learning in the operating room", and "structured training models in the operating room". Finally, application of these strategies in clinical teaching was summarized in three stages: Before operation, during operation, and after operation.

Conclusions: The operating room is a clinical facility with specific characteristics, which can challenge teaching in this setting. However, application of effective strategies and methods, as well as efficiently structured training based on the proposed models can facilitate teaching and learning enhancement in operating rooms.

Keywords: Medical, Education, Learning, Teaching Methods, Operating Room, Residency

1. Context

The operating room is a learning platform for training technical and non-technical surgical skills. Training in operating rooms helps learners from different groups, especially surgery residents, acquire the necessary clinical competencies (1, 2). The operating room is a specific environment (3), where learning is based on interactions between individuals, surgical scenarios, and educational communication between the instructor and learner (4).

In the operation room, educational communication between the clinical instructor and learner is often short, spontaneous, unplanned, and opportunistic. Although most instructors of the operation room have extensive experience in teaching in such settings, only few have the ability to enrich and optimize the opportunities and educational challenges (5). Therefore, it is necessary for clinical instructors to become acquainted with the strategies and methods of teaching and learning enhancement in

the operating room. The familiarity of surgical teachers with strategies and principles of learning increases their ability to provide effective education and creates a rewarding environment for teachers and learners to interact (1, 6).

In addition to the competencies and characteristics of clinical instructors, learning environments are among the influential factors in learning (7). In the operating room, as in other clinical settings, the learning environment plays an important role in creating learning opportunities (8). Some studies consider the clinical learning environment as a set of learning opportunities offered to learners during a teaching period (9). Undesirable learning environments prevent surgery residents from performing surgical procedures and reduce the motivation to learn surgical skills (7).

The operating room environment is highly threatening, and surgeries are quite risky in nature. In such clinical settings, human factors affect the patients safety, and surgeon's performance is a critical element in operation

success (3, 4). The limitation of training hours and potential time constraints in the operating room also affect education in this setting (2, 3). In order to remove these limitations and promote the teaching-learning process in the operating room, application of modern educational approaches and effective teaching methods are necessary (4, 6, 7).

Targeted and planned teaching can help learners become qualified surgeons (4). Experienced surgical trainers and use of effective teaching methods can provide unique opportunities in operating room training (4, 6, 7, 10). The results of numerous studies show that application of simple educational strategies or employment of teaching methods and models with a correct and multi-stage structure can help to create such educational opportunities. For instance, in a study by Kieu et al., providing feedback to learners was described as a simple learning strategy, which can be effective to enhance learning and acquiring clinical decision-making abilities in the operating room (3).

In another study by van der Houwen et al., teaching-learning processes were described as interactions between learners and clinical instructors as a model including input, process, and output. Moreover, educational strategies required for such learning processes were presented in a framework including educational strategies before, during, and after operation (11). A study by Lyon also emphasized on the dynamics of teaching-learning processes and the need to structure the training process in the operating room by presenting a model to structure teaching-learning processes in this clinical setting (12).

In general, learning in clinical situations follows clinical teaching and arises from the learners' engagement with the clinical learning environment and their participation in clinical learning activities predicted by clinical teachers (13). Therefore, the application of appropriate educational strategies and teaching methods can help to strengthen teaching and learning processes and facilitate learner empowerment. According to the necessity to improve teaching and learning processes in the operating room and the importance of applying proper teaching strategies and methods by clinical instructors, the current study aimed at reviewing several articles and introducing different strategies and methods to enhance teaching and learning in the operating room and improving the teaching-learning process in this clinical setting.

2. Methods

The current review study based on library studies and literature review aimed at investigating and introducing various strategies and methods to improve teaching and learning in the operating room and promoting the teaching-learning process in this clinical setting. In the

current study, SID and MagIran databases were searched for Farsi articles, and PubMed database was searched for English articles. The Google Scholar search engine was also used to complete the search for articles. English articles, published from 2000 to 2016, were searched with the following keywords in the title: "education and operating room", "learning and operating room", and "teaching and operating room". On the other hand, Farsi articles, published from 2006 to 2016, were retrieved using the Farsi equivalents of the English keywords.

In the first stage, a total of 60 articles including 56 English and 4 Farsi articles were found. These articles were first reviewed for repetition, and accordingly, 14 articles were excluded. In the second stage, the articles were studied in terms of title relevance, and 10 other articles were excluded. In the third stage, the articles were examined for the availability of full-text, and seven articles were excluded. In the fourth stage, the articles were re-examined in order to ensure their relevance to the purpose of the study. Finally, 22 articles were found consistent with the purpose of the study, and articles precisely providing educational strategies, models, and methods to enhance teaching and learning were included. The process of reviewing the articles is presented in Figure 1, and characteristics of articles included in the study are presented in Table 1.

3. Results

The results of reviewed articles were categorized into three general categories, including "general structure of training in the operating room", "strategies and methods to strengthen teaching and learning in the operating room", and "accurately structured training models in the operating room" (Table 2). Application of these strategies is summarized and presented as the framework of clinical education process in three stages: before operation, during operation, and after operation.

Table 2. The Main Contents of the Reviewed Articles

Column	Main Contents
1	General structure of training in the operating room
2	Strategies to strengthen teaching and learning in the operating room
3	Structured training models in the operating room

3.1. General Structure of Training in the Operating Room

Education is an interactive process, which occurs in a supporting learning environment (9). The teaching-learning process in clinical education consists of three main elements: Learner, clinical teacher or educational

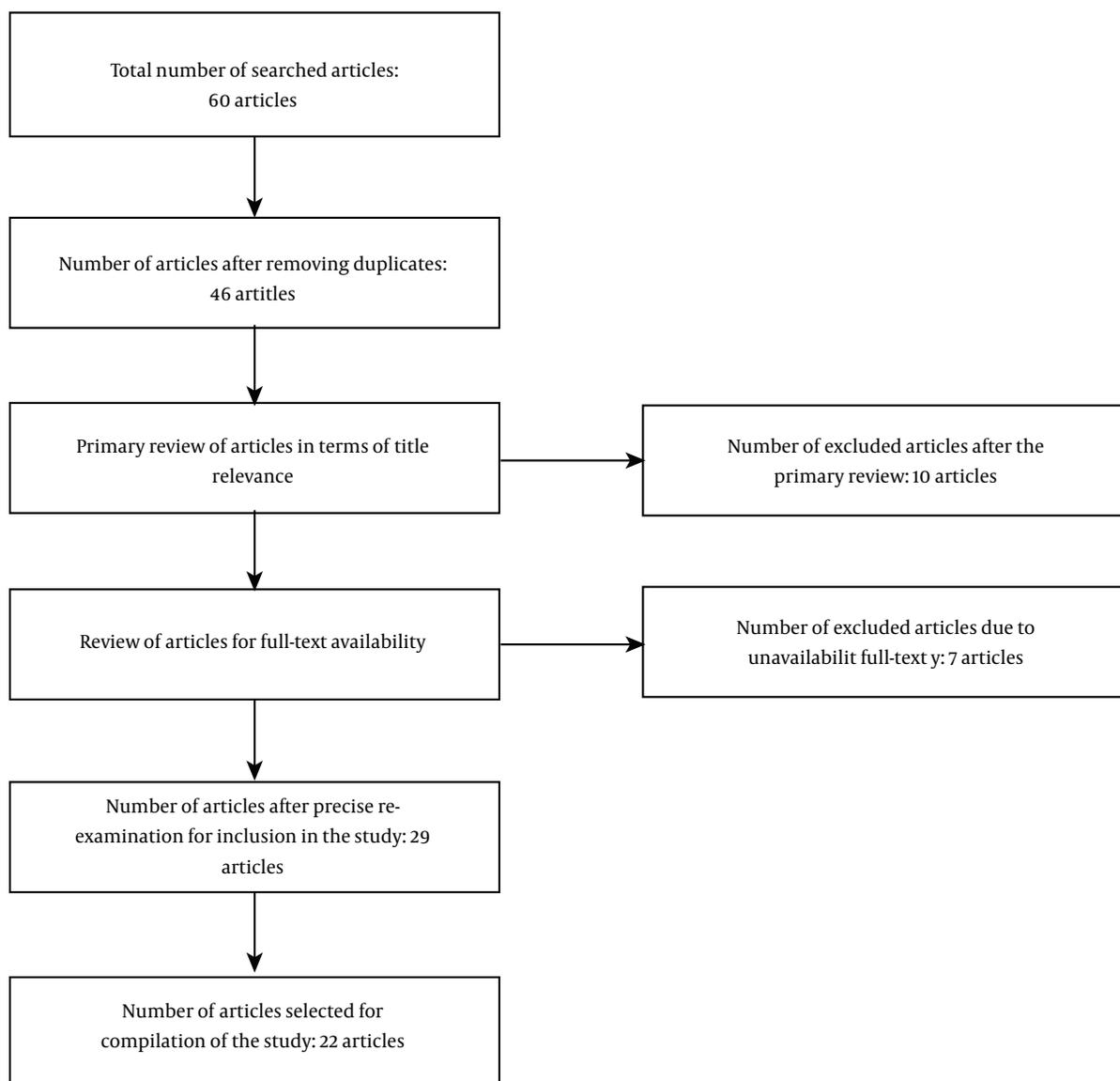


Figure 1. The articles search and selection process

observer, and learning context (8). All three elements should have the necessary features and functions to provide effective clinical teaching, which more specifically encompasses scheduled interactions and communication between the clinical instructor and learner. Similarly, training in the operating room requires effective interaction of these three elements and their practical implementation. A study by Vikis et al., described the educational measures and practices for each teaching-learning element, as shown in Figure 2 (4):

The process of clinical education in the operating room can be divided into three stages: before operation,

during operation, and after operation. At each stage, the clinical instructor and learner have responsibilities and characteristics, which can create effective teaching-learning processes. The learning context and environment should also have the proper characteristics to provide effective clinical education.

3.2. Strengthening Strategies for Teaching and Learning in the Operating Room

As mentioned in the literature, there are numerous strategies and teaching methods, which can be used to create unique opportunities to educate learners in the oper-

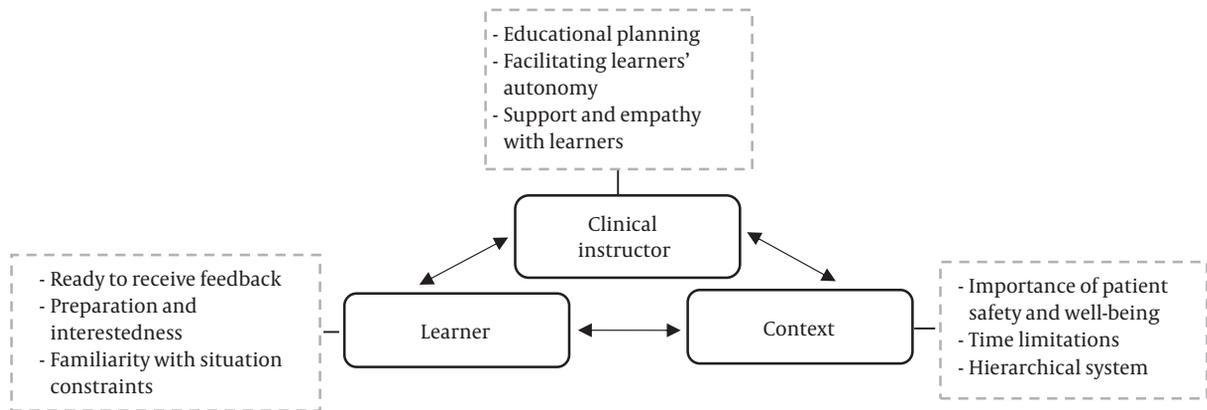


Figure 2. Interactions between the clinical instructor and learner to create educational situations

ating room. In this section, these strategies and teaching methods are introduced and presented separately.

3.2.1. Learner Preparation

One of the essential elements of teaching technical and surgical skills is the preparation of the learner for education, which is one of the important tasks of an instructor. At this stage, what the learner intends to learn is determined (6). Learner preparation before operation creates a more productive learning environment. In order to prepare the learner, there should be a mutual and targeted interaction between the instructor and learner before operation (7). The goal of this interaction is to assess the learner's needs and determine the educational purposes both for the learner and teacher (7, 27). Determination of the learning goals helps to guide learners and increases their concentration. In the communication between the instructor and learners at this stage, the learners weaknesses and needs are identified. The learners unconsciously start integrating their experiences and regularly review and reflect on them during communication (reflection before operation) (7). Moreover, at this stage, it is necessary to provide precise information about the procedure; providing this information reduces concerns and increases readiness (27).

3.2.2. Identification of Learners Level

Similar to other clinical settings, learners from different levels are present in the operating room. Along with teachers, different learners are constantly observing educational situations. In other words, medical learners, surgery residents at different levels, and surgical instructors are constantly observing each other's behaviors (11), and in many cases, the educational situation is familiar to them. It is necessary for a surgical trainer to identify

the learners' level, interpret their behaviors in order to determine their motivation and commitment (4, 12), and accordingly prepare the educational situation and adjust the training time in the operating room. In general, the instructor should involve the learners in educational situations and experiences, based on the learners' objectives and needs (12, 27).

3.2.3. Creating Learning Motivation and Interest

Motivation of learners is one of the factors that enhances learning. Enthusiasm of the instructor, which reflects his/her interest in the subject and teaching, is one of the most influential factors to encourage the learners (5). In clinical teaching in operating room, both learners and instructors should be mutually motivated. The learners should be keen on learning since the clinical instructor tends to see the interested learners (4). The learners high motivation in learning and participation in educational situations and activities, arranged by the teacher, improves their learning and practice, increases the instructor's motivation in teaching, and improves the teaching process (4, 5, 9).

3.2.4. Thorough Monitoring of Learners Performance and Patient Safety

Meeting the patients needs is the first concern of a surgical trainer (23), and patient safety in surgical training and operating room is one of the most important issues to be considered (28). Surgical training may intrinsically pose risks to the patients safety (29), and the instructor should create a balance between his/her therapeutic and educational roles. The instructor should be aware of the learners abilities and autonomy during surgical procedures, provide an appropriate learning environment, and ensure the patients safety at the same time (23). Sometimes, it is necessary for instructors to empathize with learners, support

them both psychologically and emotionally, and motivate them (4).

3.2.5. Assessment of Learners Performance and Giving Feedback

The clinical teacher should observe and evaluate the learners performance during operation, point out their weaknesses and strengths, and give them feedback; therefore, the learners can correct the shortcomings and reinforce the strengths, as it is very difficult for learners to evaluate their own performance (5). Meaningful and constructive feedback is an essential aspect of teaching and learning, which can provide learners with constructive information (30). Without giving feedback, mistakes are not corrected, clinical performance is not reinforced, and clinical competencies are either experimentally acquired or never learned (31). Feedback strengthens the reflection process and helps the learner predict future learning experiences and plans. Feedback should be purposeful and appropriate to the learners needs (32).

Feedback is provided by clinical teachers and provides reflection opportunities for learners (33). Both giving feedbacks and guiding reflection can lead to progression and improvement of professional performance (34, 35). Feedback can be provided instantaneously (immediately after the mistake) or be postponed (32). In operating room training, the clinical instructor can provide the learners with the necessary feedback immediately after observing the mistake in order to maintain patient safety during operation, or if possible, wait for the operation to end and then have a conversation with the learners to give feedback. In both cases, feedback should be provided in accordance with the principles of learners feedback. In order to teach non-technical skills in the operating room, two post-operative strategies of feedback and briefing are identified effective (16, 22). Surgery residents believe that formal and planned feedback, briefing, discussing, and interpreting after operation, are very effective in teaching non-technical skills in the operating room (16).

3.2.6. Creating and Strengthening Reflection

Reflection is a set of mental activities that learners use to explore their experiences in order to gain new insights (36). Reflection is one of the essential processes to obtain professional qualification (37). The goal of reflection in the learning process is to create meaningful and profound learning and improve performance (35). Reflection of practical and professional performance is referred to as functional reflection, which is the result of re-evaluation of practical situations to continue professional learning and progress (37). In operating room teaching, the purpose of reflection is to reflect on performance.

Medical and educational experiences and challenges in the field of medical education trigger the reflection process. There is also a direct connection between experience

and professional expertise. However, mere experience is not enough to acquire professional expertise. Experiences turn into educational opportunities and eventually facilitate learning of clinical competencies and professional expertise if there is critical reflection on performance, with a focus on performance weaknesses and performance improvement (38). In terms of time, reflection can be categorized into three classes: before, during, and after operation (39).

Since reflection enhances the learners performance and expertise acquisition, each stage of clinical teaching in the operating room can be used to create and enhance learners reflection. The learners have reflection before the operation if they unconsciously or consciously (encouraged by the clinical instructor) begin reflecting and assessing their experiences and use previous experiences to improve their performance. The learners may also have reflection during or after operation. In operating room teaching, all three reflections are valuable; however, most reflections happen after surgery, which helps both the learners and teachers determine future learning objectives and plan for clinical experiences. Therefore, reflection after surgery has several practical implications for the teachers and learners:

- Programming and thinking about the ways to improve performance and correct weaknesses.

- Guiding the learners in order to determine their needs and objectives for future learning.

- Helping the teachers determine the learning experiences and future educational challenges.

3.2.7. Using a Structured Teaching Framework

Using a structured teaching framework facilitates the application of educational principles in the process of surgical education and increases the educational opportunities (15).

3.2.8. Positive Role Modeling

The importance of teaching and learning through role modeling in operating room teaching is described in numerous studies (17, 40, 41). Learners mainly learn behaviors and skills through observing roles in the operating room. Behaviors such as teamwork, interactions with the patients and colleagues, respect, and composure are among skills acquired by role modeling in the operating room (17).

3.2.9. Improvement of Learning Context

3.2.9.1. Creating a Constructive Learning Environment

The environment in which learning takes place can be either a stimulating environment, which improves learning, or an inhibiting environment, which obstructs learning. Features of a supporting learning environment are

similar to those of a satisfactory work environment. These features include mutual respect and interaction, shared vision, group reflection, and support preference over blame. In teaching hospitals and departments, “learning” is a very important issue. In these hospitals, learners are legal participants in learning activities, and their learning needs should be addressed. It means that learners should engage in constructive and meaningful clinical activities to be able to act independently (5).

The quality of clinical experience represents and guarantees the quality of medical education (9). In order to determine the quality of learning experiences, there is a need to examine evidence, which improves learning (9). Active engagement and participation of learners are keys to effective learning in the operating room (12). In operating room teaching, a constructive learning environment includes programming learning activities, meaningful clinical experiences, and active participation of learners (25) with the help of surgeons that can be effective and positive role models for learners (5, 9).

3.2.9.2. Group Communication and Positive Interactions

The process of training an apprentice into a competent surgeon is heavily influenced by communications in the operating room (22). Positive interactions in the operating room reinforce learning, and open communication is essential to learning improvement. On the other hand, poor and inappropriate group interactions and communication negatively affect both patient safety and learning process (4).

In a study by Roberts et al., which examined the analysis of oral and verbal interactions between the instructor and learner, four categories of interactions were identified including instrumental communications, pure teaching communications, instrumental and teaching communications, and interactions regardless of surgery (Burnet). The purpose of instrumental communications is interaction between the learner and teacher in relation to the way the operation is performed. These interactions are mostly aimed at promoting operations and have few educational purposes. On the contrary, pure teaching communications are purpose-oriented and only related to learner education (10).

3.2.10. Video-Based Training

Application of video recording during surgery is a new and applicable method, which can complement training in the operating room (14). The findings show that application of this method is very suitable for teaching high levels of cognition such as clinical decision-making, individual training, and feedback. Both residents and teachers claim that this training method is useful for training in the operating room; in addition to increasing educational opportunities, it reduces the pressure of teaching in the operat-

ing room (14). Video-based learning has many advantages including increased concentration on learning, creating valuable learning opportunities, providing feedback, and facilitating cognitive thinking (14).

3.3. Models with a Proper Structure for Teaching in the Operating Room

Sometimes, structured models are used to facilitate teaching in the operating room. Two of the most important training models in the operating room include the Zwisch and briefing, intraoperative teaching, debriefing (BID) models.

3.3.1. The Zwisch Model

This model was presented by DaRosa et al., for teaching and evaluating the operating room. This model provides four levels of supervision and teaching by instructors, including “show and tell”, “smart help”, “dumb help”, and “no help”. In this model, at each level, the teacher’s intervention is reduced and the learners autonomy in operation is increased. At each level, specific types of behavior and performance are determined for the learners and surgical instructors. Zwisch model is designed for the learners step-by-step progress towards autonomy in surgery (19).

3.3.2. BID Model

This model is one of the most suitable models for purposeful teaching in the operating room. BID is an acronym for:

3.3.2.1. Briefing

It is conducted two to three minutes before surgery. The clinical teacher examines the learners needs through conversation and questions.

3.3.2.2. Intraoperative Teaching

It is performed during surgery. The teacher instructs and guides the learners in accordance with their needs.

3.3.2.3. Debriefing

The teacher asks questions to encourage the learners to evaluate and reflect on their own performance. The learners begin investigation and reflection on their own performance and determine their future learning objectives. Generally, this stage has four learning outcomes, including “reflecting”, “improving performance”, “correcting performance”, and “planning for future objectives”.

3.4. The Proposed General Format for Clinical Teaching in the Operating Room

A set of teaching and learning reinforcement strategies in the operating room can be summarized, categorized, and presented in three stages; i e, before, during, and after operation [Figure 3](#).

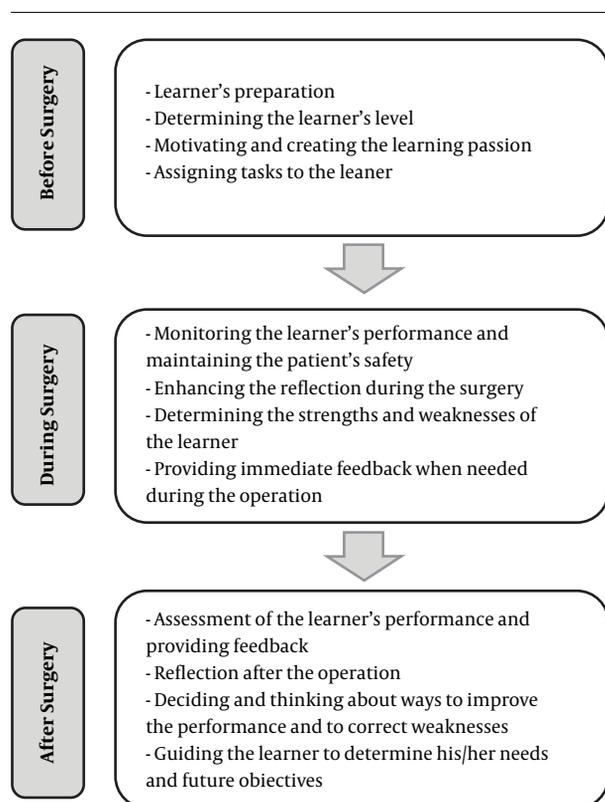


Figure 3. The overall format proposed for clinical teaching in the operating room

4. Discussion

The current study aimed at reviewing a number of studies in order to introduce effective teaching strategies and methods to strengthen teaching and learning in the operating room. The results were divided into three categories: "General structure of training in the operating room", "strategies for strengthening teaching and learning in the operating room" (i.e. learner preparation, identification of learners level, motivating and creating learning interest, careful monitoring of learners and maintaining patients safety, assessment of learners performance, providing feedback, creation and enhancement of reflection, application of a structured training framework, positive role modeling, improving the learning situation, and video-based education), and "structured training models in the operating room" (i.e. the Zwisch and BID models). Subsequently, these strategies were expressed in form of a complete training process in the operating room. Generally, the goal of training in the operating room should be turning pure discovery learning into guided discovery learning (20); in fact, the application of teaching strategies can make such conversion possible.

The presented strategies, including feedback strategy,

were noted in most studies. Feedback is an important teaching-learning principle, which has a significant impact on the improvement of learning, especially in clinical and practical skill training in operating rooms (16-20, 26). Learning in the operating room is "learning by doing", which is not effective without providing constructive feedback to learners (20). In order to have effective feedback, it should be presented in accordance with feedback principles. In a study by Snyder et al., residents claimed that they received less feedback than what clinical teachers believed; this could be due to the fact that feedback was not presented constructively (20).

One of the teaching methods, which can improve learning in the operating room, is video-based teaching. One of the influential features of this method is providing feedback to learners (14). Residents believe that surgeons often investigate and evaluate their previous experiences, but rarely help them determine their learning goals or provide feedback after surgery. By using structured teaching techniques in clinical operating room training, one can integrate effective strategies to improve the learners education. For instance, in the BID model, the teacher can investigate the needs and objectives of the learners and set future objectives (20).

In a study by Leung et al., the effect of structuring educational situations in the operating room was studied based on a specific teaching format, focused on setting goals and providing feedback after the operation. Their results showed that application of educational frameworks to structure educational situations in the operating room increased the satisfaction of surgeons and residents, provided an opportunity to give feedback, and improved the concentration on learning objectives (15).

Structuring educational challenges requires an experienced clinical instructor for teaching and mentoring. In a study by Skoczylas et al., seven common features of a clinical instructor were described as follows: emphasis on anatomical symptoms, supportive use of perceptual-motor teaching (learners are trained in a way that they can combine their perceptions and motor senses during surgery and procedures), encouraging practice and repetition, strengthening primary autonomy, exuding confidence, showing composure in the operating room, and accepting the responsibility for mistakes and their consequences (21).

Surgical trainers typically instruct learners by using rapid and effective, but untested methods. Instructors in an environment such as the operating room, should help learners apply their knowledge in the process of clinical reasoning, give them feedback, and develop clinical independence in learners (21); these features of clinical trainers can be integrated into the Zwisch model (19). In fact, the application of structured teaching methods can improve teaching and learning processes in clinical situa-

tions, particularly challenging situations such as the operating room.

The current review study included several articles, as presented in Table 1. Nevertheless, future studies can provide more profound results by searching more databases and using more keywords. It is suggested that a more comprehensive review, as well as empirical analysis, be implemented to examine each of these methods to improve operating room teaching in Iran.

4.1. Conclusions

The operating room is a clinical facility with specific teaching challenges. According to the importance and necessity of learning practical and surgical skills and maintaining patient safety in this clinical setting, it is essential for clinical instructors to become familiar with strategies and methods of teaching and learning and facilitate learners' progress via appropriate application of such methods. With the help of targeted and planned training in the operating room via effective teaching methods and providing structured training, based on the presented models, the educational constraints can be overcome and teaching of competent and skilled surgeons can be facilitated.

Supplementary Material

Supplementary material(s) is available [here](#) [To read supplementary materials, please refer to the journal website and open PDF/HTML].

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Table 1. The Characteristics of the Selected Articles

Source	Journal	Study Design	Study Population	Sample Size	Intervention
Hu et al. (14)	JAMA Surgery	Mixed method	Residents and surgery trainers	10 residents (fourth- and fifth-year medical students)	Video recording of educational surgeries and studying the effects of video-based training
Leung et al. (15)	Australian and New Zealand Journal of Obstetrics and Gynecology	Mixed method	Residents and surgery trainers	64 surgical procedures studied in a structured method	Structuring educational challenges in the operating room and examining educational impacts
Dedy et al. (16)	Annals of Surgery	Non-randomized clinical trial	Surgery residents	Routine surgeries of 11 senior residents (year 3 to 5) and 69 surgeries	Studying the effects of two feedback strategies and examining non-technical skills in the operating room
Hampton et al. (17)	American Journal of Obstetrics and Gynecology	Review	-	-	Review of teaching reinforcement strategies in the operating room
Schenarts and Flowers (18)	JAMA Surgery	Commentary	-	-	Introducing feedback as the best strategy in operating room training
DaRosa et al. (19)	Journal of Surgical Education	-	-	-	Proposing a training model called the Zwisch model for operating room training
Snyder et al. (20)	Journal of Surgical Education	Descriptive	Accreditation Council for Graduate Medical Education (ACGME)	258 surgical programs	Evaluation of operation programs in an online survey
Skoczylas et al. (21)	Academic Medicine	Grand theory	-	5 instructors of gynecology and 16 midwifery interns	Identifying the characteristics and competencies of operation room instructors
Roberts et al. (10)	Surgery	Grand theory	-	1306 interactions	Study of verbal interactions between teachers and learners during operations
van der Houwen et al. (11)	European Journal of Obstetrics and Gynecology and Reproductive Biology	Qualitative	Learners of gynecological surgeries at different levels	-	Presenting a model of skill acquisition in the operating room
Kieu et al. (3)	Education for Health	Qualitative	Surgeons and learners of surgeries at different levels	10 teachers and surgical learners	Analysis of perceptions of surgical teachers and learners about education based on competence in the operating room
Jeffree and Clarke (5)	World Journal of Surgery	Review	-	-	Review of studies in order to provide strategies to strengthen surgical education
Lyon (12)	Medical Education	Multi-method	-	25 teachers and surgery residents	Introducing a teaching-learning model in the operating room
Vikis et al. (4)	The American Journal of Surgery	Qualitative	-	18 surgery residents	Investigating the learners' perceptions about effective educational interactions

Champagne (7)	Clinics in Colon and Rectal Surgery	Review	-	-	Review of studies to provide strategies to strengthen surgical education
Kanashiro et al. (2)	Surgery	Descriptive	General surgery residents	-	Evaluation of operating rooms using a questionnaire (OREEM)
Yule (22)	Surgery	Review	-	-	Study of non-technical skills for surgeons in the operating room
Cox and Swanson (23)	The American Journal of Surgery	Descriptive	Teachers and general surgery residents	20 teachers and 49 general surgery residents at different levels	Study of teaching behaviors in the operating room
Schwind et al. (9)	The American Journal of Surgery	Descriptive	-	114 periods of learning in the operating room	Study of effective factors on learning in the operating room
Roberts et al. (24)	American College of Surgeons	-	-	-	Providing a model of teaching in the operating room: Briefing, intraoperative teaching, debriefing (BID)
Meyer (25)	Nurse Education in Practice	Qualitative	-	65 nursing students	Analysis of operating room learning environments
Mirbagher Ajorpaz (26)	Nursing Education Journal	Review	-	-	Study of the role of mentoring in operating room training