

ORIGINAL ARTICLE

Effectiveness of midline catheter insertion course in improving procedural skills for emergency physicians and nurses

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ABSTRACT

Background: Midline catheters (MCs) are effective and safe devices that provide patients with intravenous access within hospitals and healthcare facilities. This study aimed to investigate emergency medicine physicians' and nurses' clinical skills and confidence in performing MC insertion after a directed simulation course.

Methods: This single-center study was conducted in King Faisal Specialist Hospital, Riyadh, Saudi Arabia, among physicians and nurses in the emergency department. The study participants were recruited into a simulation course. The participants' practical skills were assessed for quality improvement, and retrospectively, the difference in pre-post measurement was analyzed, and a cross-sectional part included a survey of self-rated comfort levels.

Results: A total of 51 participants were included in the study. Two-thirds of the participants were physicians (66.7%), worked more than 15 shifts (66.7%), and were Saudi (66.7%). Most worked in governmental hospitals (90.2%), and about half were residents (43.1%). There was a significantly high level of agreement among the participants regarding the advantages of using a MC over central venous catheters (p -value < 0.001). Participants' total score regarding the comfort level in placing ultrasound-guided MCs and MC insertion procedural skills was significantly better after the training (p -value < 0.001 and <0.001, respectively). In addition, physicians showed significantly higher scores in improving their procedural skills after the training (p -value < 0.001).

Conclusion: Midline catheters are a valuable device that can improve the management of such patients. Therefore, they should have adequate knowledge and acquired practical skills regarding managing MC devices. Physicians could achieve these skills through continuous training and practice.

Keywords: Emergency medicine, midline, central lines, simulation.

Introduction

Midline catheters (MCs) or medial venous catheters are devices composed of polyurethane or silicone, have up to two lumens, and have an available range of sizes. They are about 8-20 cm long and are accessed in the periphery of the upper arm or antecubital fossa, with the tip at the axillary vein or below it [1-3]. The MC was initially produced in the 1950s and utilized as a peripheral vascular access approach into the 1990s [4].

MCs are designed for intravenous therapies with an intermediate duration (generally ranging from 5 to 14 days) [5]. In addition, they are not regarded to dwell in the central circulation, such as central venous catheters (CVC) or peripherally inserted central catheters (PICC) [6].

MCs have shown multiple benefits, including providing a continuous intravenous infusion of drugs, lower rates of

needle sticks, reducing the risk of phlebitis, cost-benefit potency for the hospital, and low rates of complications such as infections and catheter-related thrombosis. Thus, MCs are the primary type of catheters for patients requiring long-term infusion and could be a suitable alternative to the PICC or short peripheral intravenous catheters [7-9].

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Early utilization of MCs in the emergency department (ED) for patients with difficult peripheral venous access or anticipated lengthy hospitalization could be valuable in many aspects. For example, reducing hospital service costs, lowering catheter-related complications, and consequently, helping manage the increased pressure on healthcare providers to achieve patient satisfaction [7,10,11].

Furthermore, satisfactory medical service can be provided through the education and training of the medical staff. For instance, the ED staff plays a significant role in managing critically ill patients, so improving their practical skills should be continuous. After technological developments, learning in real situations became a less popular approach to teaching medical professionals. Thus, simulation training is a preferred and effective method that maintains patient safety. The simulation also allows the learners to develop expertise, comfort, and skills and deal with less common situations without assessing patients [12,13].

To the best of our knowledge, no previous studies in Saudi Arabia were published investigating the impact of simulation courses on healthcare providers working in the ED; thus, this study was conducted to assess the clinical skills and confidence of emergency medicine physicians, residents, and nurses in performing MC insertion after a directed simulation course.

Methods

Study design and setting

This single-center study was conducted in King Faisal Specialist Hospital, Riyadh, Saudi Arabia. It is a mixed-method study with a retrospective part and a cross-sectional part. The first part included a simulation course being done routinely in the ED as part of the training requirement of the physicians and nurses. The practical skills of the participants were assessed for quality improvement purposes by the ED. The course provider did the assessment using a pre-post objective structured clinical examination on the same day. The difference in pre-post measurement was analyzed. The cross-sectional part of the research was done using a survey of self-rated comfort levels (designed by the authors) through a five-point Likert scale.

Study populations

Emergency medicine physicians, residents, and nurses were invited to participate in the study. Quota sampling was followed in the study. A total of 55 physicians and nurses attended the training. Of these, 51 physicians and nurses were included in the study, while four nurses were excluded because they were not emergency medicine nurses.

Statistical analysis

Data were extracted and entered into a Microsoft Excel sheet. Data were statistically described in terms of continuous data median [interquartile range (IQR)]. Frequencies (n) and percentages (%) were used for

categorical variables. For calculating the score of participants' answers on agreement with the advantages of using MCs over the CVC five-point Likert scale questionnaire (strongly disagree, disagree, neutral, agree, and strongly agree), responders' answers were converted to scores from one to five where one represents strongly disagree and five represents strongly agree.

For calculating the total score of the responses to the six-point Likert scale questionnaire regarding comfort in placing ultrasound-guided MCs (extremely uncomfortable, moderately uncomfortable, mildly uncomfortable, mildly comfortable, moderately comfortable, and extremely comfortable), responders' answers were converted to scores from zero to five where zero represents extremely uncomfortable, and five represents extremely comfortable.

Regarding the procedural skills of MC insertion before and after the training, each participant was given a score of one to five points for each skill where 1 = "Sub-optimal," 2 = "Needs improvement," 3 = "Fair," 4 = "Good," and 5 = "Excellent." A total score (out of 35 points) was calculated for each participant before and after the training.

Nonparametric tests were used; the Wilcoxon Signed Rank Test was used to compare the respondents' scores before and after the training. The Mann-Whitney test was used to investigate the association between the total score and the demographic characteristics. p -values less than 0.05 were considered statistically significant. All statistical calculations were done using the computer program IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, NY), release 26 for Microsoft Windows.

Results

In total, 51 participants were included in the study, and their complete characteristics are shown in Table 1. Approximately two-thirds of them were physicians (66.7%), worked more than 15 shifts (66.7%), were Saudi participants (66.7%), and all of them were from the central region (100%). The majority of the respondents worked in governmental hospitals (90.2%). About half of them were residents (43.1%).

The participants' answers to the questions assessing the agreement level on the advantages of using MC over the CVC were compared. There was a higher statistically significant agreement (p -value < 0.001) on using MC over CVC in all aspects. Full details are illustrated in Table 2 and Figure 1.

By comparing the overall score of the respondents' comfort level in placing ultrasound-guided MCs before and after simulation training, the score after the training was significantly higher than before (p -value < 0.001). Full details are illustrated in Table 3.

The ranking distribution for procedural skills' score on midline insertion after the training was significantly higher than before (p -value < 0.001). In addition, the scores for all aspects of procedural skills were significantly higher after the course than before the training (p -value < 0.001). All details are described in Table 4 and Figure 2.

After comparing the total score of the participants after training with the participants' characteristics, physicians had a significantly higher score than nurses (p -value < 0.001). Meanwhile, gender, type of hospital, and the number of clinical shifts had no significant impact on the total score. All details are in Table 5.

Discussion

There has been an increase in interest in using MC devices in hospitals to avoid adverse events that occasionally occur by using PICCs [14]. MCs are CVC, so they do not cause central line-associated bloodstream infections. In addition, they are longer than other peripheral intravenous catheters and can dwell deeper than standard peripheral intravenous catheters. Despite its frequent use, venous access in the ED is an often-under-appreciated procedural skill [6,7]. This study aimed to evaluate the clinical skills and confidence of emergency medicine

physicians, residents, and nurses in performing MC insertion after a directed simulation course.

Usually, inserting intravenous access in the ED may fail in about 25% of the cases, especially in certain conditions, including obesity, hypovolemia, chronic medical disorders, history of intravenous drug use, or vascular diseases [15]. Thus, introducing training is essential to enhance healthcare providers' skills and maintain patients' comfort.

Most studies only examined the use of MCs in the ED, especially in patients with difficult access, with no regard to assessing the effectiveness of training courses [16-18,10,11]. To our knowledge, this is the only cross-sectional study investigating the impact of simulation courses on the clinical skills and confidence of emergency medicine physicians, residents, and nurses in performing MC insertion in Saudi Arabia.

In our study, the participants attended a simulation workshop on placing ultrasound-guided MCs and their insertion procedures. It was indicated that the workshop was valuable, and the participants from physicians and nurses reported significantly higher scores after attending the workshop than before training. In addition, the procedural skills of the participants, including anatomical landmarks, ultrasound skills, sterile field preparation, introducing the guidewire, introducing the catheter, and applying the catheter caps, were improved after the training.

On the other hand, the ultrasound guide for inserting the cannula in the basilic and brachial veins has been estimated to be helpful in an ED. Doctors and nurses are practicing it in the same way [19,20]. Ultrasound guidance is adopted worldwide, and MCs are now frequently inserted by the modified Seldinger method [21]. The insertion of MCs with ultrasound guidance has multiple benefits, including that it is a safe, inexpensive, and easy method for most patients; in addition, it is helpful in correlating the location of the tip of MC with the incidence of catheter-related venous thrombosis or malfunction [22]. As a consequence of these benefits, the participants in our study trained on using it and showed a significantly better score after training than before training.

Although nurses work longer hours in contact with patients and usually perform most invasive procedures, such as catheter insertion, physicians showed significantly better scores regarding procedural skills after training than nurses. In a similar concept, a study by Eraso et al.

Table 1. Baseline characteristics of the participants.

Study variables	Frequency (n = 51)	Percent
Job title		
Physician	34	66.7
Nurse	17	33.3
Gender		
Male	28	54.9
Female	23	45.1
Nationality		
Saudi	34	66.7
Non Saudi	17	33.3
Place of residence		
Central region	51	100.0
Type of hospital		
Governmental	46	90.2
Military	1	2.0
Private	4	7.8
Number of emergency medicine practice years		
Currently still a resident	22	43.1
2-5 years	8	15.7
6-10 years	9	17.6
11-15 years	4	7.8
16-20 years	8	15.7
Number of clinical shifts (Average per month in emergency medicine)		
11-15 shifts	17	33.3
>15 shifts	34	66.7

Table 2. The respondents' level of agreement on the advantages of using a MC over CVC (n = 51).

Factor	Median	IQR	p-value
Easy to use	5	0	<0.001
Faster	5	0	<0.001
Fewer mechanical complications	5	0	<0.001
Less infectious complications	5	0	<0.001
Fewer placement failures	5	1	<0.001
Beneficial for patients lacking anatomical landmark	5	0	<0.001

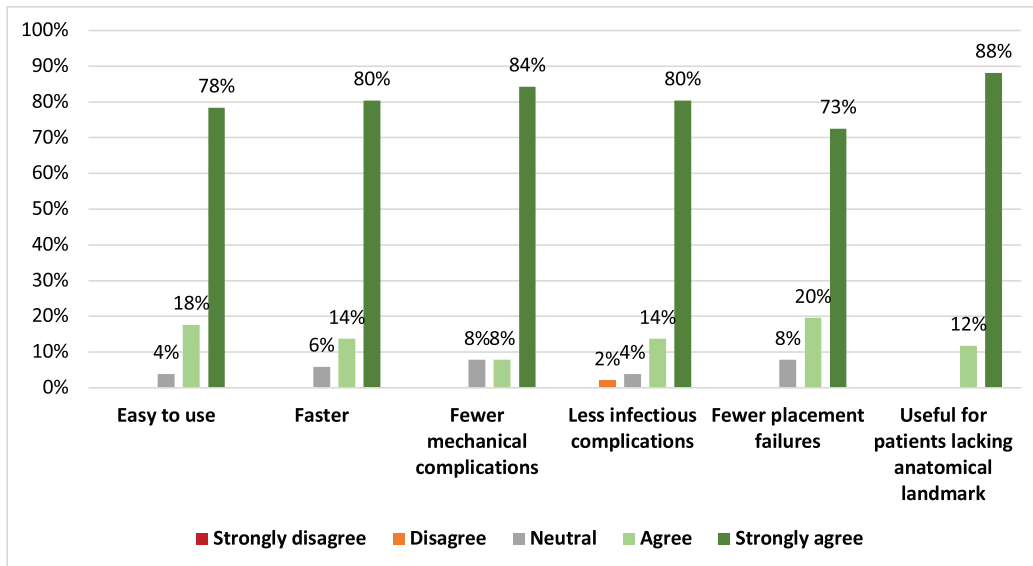


Figure 1. The frequency of the participant's answers to the questions about the advantages of using a MC over CVC.

Table 3. The respondents' level of comfort in placing ultrasound-guided MC before and after training (n = 51).

Factor	Before training		After training		p-value*
	Median	IQR	Median	IQR	
Level of comfort in placing ultrasound-guided MCs	0	0	5	1	<0.001

*Related-samples Wilcoxon Signed Rank test at a 0.05 level of significance.

Table 4. Effectiveness of a MC insertion course in improving procedural skills (n = 51).

Procedural skills	Before training		After training		p-value*
	Median	IQR	Median	IQR	
Anatomical landmark	3	3	5	0	<0.001
Ultrasound skills	4	3	5	0	<0.001
Sterile field preparation	5	1	5	0	<0.001
Introducing the guidewire	2	1	5	0	<0.001
Introducing the catheter	2	1	5	0	<0.001
Applying the catheter caps	3	1	5	0	<0.001
Applying the dressing	3	2	5	0	<0.001
Total score	21	9	35	0	<0.001

*Related-samples Wilcoxon Signed Rank test at a 0.05 level of significance.

[23] revealed that emergency physicians could safely place MCs with few complications.

Furthermore, most participants strongly agreed that MCs are easy to use, faster, have fewer mechanical complications, infectious complications, and placement failure rates, and are helpful for patients lacking anatomical landmarks. This opinion is supported by a previous review which stated that newer MCs produced from hydrophilic biomaterials could limit the foreign body response as they mimic the body's chemistry. In addition, these MCs have the potential to limit frequent complications, lowering costs across healthcare facilities and positively impacting patients [24].

This study assessed the effectiveness of the MC insertion course in improving procedural skills through subjective tools without examination of the practical skills on the

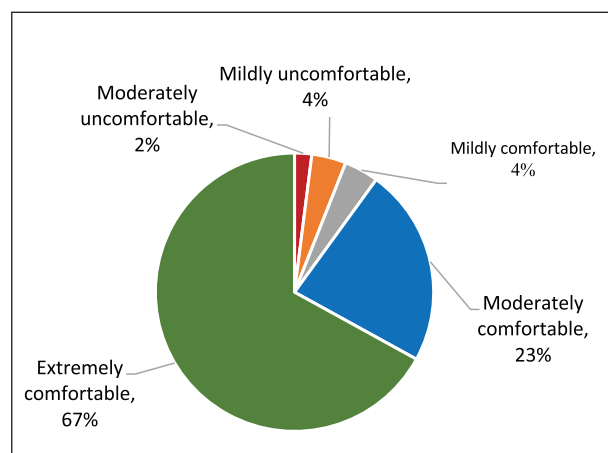


Figure 2. The frequency of the answers to the level of comfort in placing ultrasound-guided MC after training.

Table 5. Total score after the training compared over the participants' characteristics (n = 51).

Score		Median	IQR	p-value
Job title	Physician	35	0	<0.001*
	Nurse	32	6	
Gender	Male	35	0	0.252*
	Female	35	1	
Type of hospital	Governmental	35	0	0.480*
	Private	35	0	
Number of clinical shifts (average per month)	11-15 shifts	35	3	0.374*
	>15 shifts	35	0	

*Independent-Samples Mann-Whitney U test at a 0.05 level.

ground. Further studies should include subjective tools with practical analysis in evaluating the effectiveness of the training courses.

Conclusion

According to our results, the total scores of the trained participants regarding the comfort level in placing ultrasound-guided MCs and improving procedural skills of MC insertion after the training were significantly higher than their scores before the training. Furthermore, physicians had considerably better scores than nurses. Medical staff in the ED, including physicians and nurses, play a significant role in managing critically ill patients and patient education on how to deal safely with such devices. Therefore, medical staff must possess expert knowledge of MC replacement, management, and potential complications. Thus, applying training programs is an efficient way to develop their skills. It is also recommended that decision-makers implement continuous training programs in the hospitals, which can lead to improving medical care and patient outcomes.

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List of Abbreviations

CVC	Central venous catheters
ED	Emergency department
MC	Midline catheters
PICC	Peripherally inserted central catheters

Conflict of interests

The authors declare there is no conflict of interest regarding the publication of this article.

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Consent to participate

Written informed consent was obtained from all the participants.

Ethical approval

Ethical approval was granted by the Ethics Committee/ Institutional Review Board/Research Committee at King Faisal Specialist Hospital and Research Center in Riyadh,

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