
Effect of Designed Protocol on Critical Care Nurses' Performance Regarding Cerebral Angiography and Patients' Outcomes

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Abstract

Background: Cerebral angiography is a standard invasive and diagnostic procedure with great sensitivity. It is used for the diagnosis of a wide range of cerebral problems. **Aim:** Was to evaluate the effect of designed protocol on critical care nurses' performance regarding cerebral angiography and patients' outcomes. **Design:** A quasi experimental design was used. **Setting:** study conducted in Neurological Intensive Care Unit at Zagazig University Hospitals. **Sample:** A Convenient sample of 30 nurses and all available patients (30) undergoing cerebral angiography. **Tools:** Five tools were utilized; Interviewing questionnaire for nurses; observational checklists for nurses, interviewing questionnaire for patient, vascular complications assessment questionnaire, and Critical-Care Pain Observation Scale. **Results:** Mean scores of nurses' knowledge and practice increased significantly after designed protocol. Also, 60% of studied patients had subarachnoid hemorrhage and 53.3% were diabetic, 86.7% were hypertensive and 66.7% had interventional cerebral angiography, 93.3% of studied patients had headache and 53.3% had fainting. Also, there was a statistical significant decrease in hematoma formation and access site symptoms after designed protocol, in addition to significant decrease in pain. **Conclusion:** There was a significant improvement of critical care nurses' knowledge and practice after the designed protocol, which reflected then on improvement of patients' outcomes through reduction of postoperative complications for patients undergoing cerebral angiography and pain improvement. **Recommendations:** Continuous training program should be applied for critical care nurses regarding care of patients undergoing cerebral angiography for updating their knowledge and practice.

Keywords: *Cerebral Angiography, Critical Care, Designed protocol, & Nurses' performance.*

Introduction:

Cerebral angiography is a highly sensitive, invasive and diagnostic procedure. It is used to diagnose brain problems such as cerebral arterial stenosis, cerebral aneurysm, cerebral arteriovenous malformations, intracranial hemorrhage, subarachnoid hemorrhage, ischemic stroke, and brain tumors (Schindler et al., 2020).

Hazards of cerebral angiography are higher in advanced age, patients with severe atherosclerosis, pre-existing symptomatic cerebrovascular diseases, acute subarachnoid hemorrhage, tortuous vessels, sickle cell disease, certain vascular dysplasias, and possibly in patients with a history of migraine headache. These hazards depend on duration of the procedure, catheter size, the number of catheter exchanges, extent of catheter manipulation, and amount of contrast utilized (Voss, et al., 2020).

The chance of any complication with a cerebral angiography is small. However, it is important to be aware of potential risks such as internal hemorrhage, damaged blood vessel, infection, allergic reaction to the contrast agents, and stroke. Cerebral angiography was associated with an overall risk of neurological

loss of 1% and permanent deficiency of 0.5% (Khanna et al., 2019).

Nursing intervention is an essential part in patient care pre and post procedure, patient education and patient monitoring intra and post procedural. Minimizing complications, especially hematoma formation, which is the most common complications at access site, is the nursing priority post cerebral angiography (Li, et al., 2020 & Allsasmah, 2020). Identification and early management of complications is often the responsibility of nursing staff. Nurses have the opportunities to use non-pharmacological methods to relieve patients' pain (Fernandez, et al., 2021). Cryotherapy is a simple and cheap treatment has been a successful method of non-pharmacologic pain management for decades. It increases the pain threshold and minimizes the inflammatory response (Jarva et al., 2021).

The patient should not be discharged before vital signs, level of consciousness and motor function has returned to pre procedural baseline (Ashcraft et al., 2021). The patient is given discharge instructions about identifying potential complications such as (bleeding at access site, neurological deficit, decreased urinary output, pain and distal puncture site

discoloration) and seeking medical advice if such complications occur. Discharge instructions should also include advice on driving, diet, physical activity, and follow-up (Chadwick, 2019).

Significance of the study:

Despite the beneficial effect of cerebral angiography which is considered a safe and effective procedure, it may be associated with morbidity and mortality risk (Woo et al., 2020). Complications associated with cerebral angiography include reversible neurological complication such as mild to moderate changes in level of consciousness or irreversible severe changes in level of consciousness as well as, the non-neurological complications as pain, hematoma formation, access site infection, and bleeding which can be life threatening and all of which require additional nursing intervention, medical care or even surgical interference (Oliveira et al., 2022).

Professional nursing care has a clear and positive impact on patients' outcomes immediately after and during the early stages of cerebral angiography, as pain, bleeding and hematoma management are considered the top nursing priority (Zidan et al., 2018). This will assist critical care nurses to determine the most appropriate methods to minimize complications and provide a quality nursing care to these patients (Goo, 2019). Therefore, this study was conducted to evaluate the effect of designed protocol on critical care nurses' performance regarding cerebral angiography and patients' outcomes.

Aim of the study:

Study aim was to evaluate the effect of designed protocol on critical care nurses' performance regarding cerebral angiography and patients' outcomes.

Objectives:

- Assess nurses' knowledge and practice regarding cerebral angiography.
- Assess complication among patients undergoing cerebral angiography.
- Implement designed protocol for critical care nurses based on their needs.
- Evaluate the effect of designed protocol on critical care nurses' performance regarding cerebral angiography and patients' outcomes.

Research hypotheses:

- H1: Critical care nurses' knowledge will be higher after designed protocol than before.
- H2: Critical care nurses' practice will improve after designed protocol than before.
- H3: Patients are expected to have less complication after designed protocol.

Subjects and methods:

Research design:

Pre/posttest quasi experimental design was used. A quasi-experimental design is a useful tool in situations where real experiments cannot be used for ethical or practical reasons because it uses a non-random method to assign subjects to groups (Thomas, 2020).

Setting:

The study was established in Neurological Intensive Care Unit of Accidental Hospital, Zagazig University Hospitals which located in the fourth floor consisted of ten beds. Neurological ICU beds equipped with monitoring devices which allow nurses at the nursing station to monitor the patient 24 hours around-the-clock. Each bed may accommodate a ventilator.

Sample:

- A Convenient sample of 30 nurses who cared patients undergoing cerebral angiography and accepted to participate in the study.
- All available patients (30) undergoing cerebral angiography during study periods.
- The sample was randomly selected. The sample was computed by power and sample size estimation program to provide power of 80% at confidence level 95%. The estimated sample size. The formula of calculating sample size was

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{(N-1) \cdot e^2 + Z^2 \cdot p \cdot (1-p)}$$

Data collection tools:

For nurses:

Tool I-Interviewing Questionnaire for Nurses: It was designed by researchers after reviewing of relevant literature (Schwegel, et al., 2019) and contained the following four main parts:

Part 1: Demographic characteristics of studied nurses as age, sex, marital status, level of education, years of experience, and training courses.

Part 2: Questions to assess nurses' knowledge regarding cerebral angiography; definition indications, contraindications, types, complications of cerebral angiography, patient's position after cerebral angiography, patient movement, neurological assessment, pain assessment and management, and patient's discharge instruction.

Part 3: Questions to assess nurses' knowledge regarding nursing care for complications after cerebral angiography such as hematoma and bleeding, standard precautions of infection control, and pain management.

Part 4: Questions to assess nurses' knowledge regarding discharge instructions given to patient including prevention of bleeding, hematoma, local

infection, warning signs and dietary, therapeutic regimen, as well as follow up.

Tool II- Observational Checklists: to assess nurses' practice regarding care of patients undergoing cerebral angiography. It consisted of checklists on immediate care post procedure, ongoing care, pain management, management of bleeding and hematoma, and care of access site, adopted from (Shoamanesh, et al., 2021).

For Patients:

Tool I-Interviewing Questionnaire for Patient: It was designed by researchers including three main parts:

Part 1: Demographic characteristics of studied patients as age, sex, marital status, level of education, residence, occupation, and smoking history.

Part 2: Past medical and surgical history of patient: history of neurological disease, vascular diseases, previous hospitalization, surgical history, and allergy.

Part 3: Present medical history: as cardiovascular, respiratory, kidney, Musculoskeletal, hematology diseases, types of cerebral angiography. Also, neurological symptoms such as headache, seizure, dizziness, fainting, vomiting, tinnitus, tingling, or numbness were assessed.

Tool II- Vascular Complications Assessment Questionnaire: It was used to measure hematoma formation and bleeding post cerebral angiography and local access site infection including two parts:

Part 1: Hemostatic Scale: It was adopted from (Schwarz, et al., 2022). And used for assessment of access site hematoma formation and bleeding, graded on an ordinal scale, from 0 to 4 as the following: 0 for no bleeding or no hematoma, 1 for small hematoma or scant oozing, 2 for moderate hematoma or bleeding, 3 for large hematoma or bleeding, and 4 for large hematoma which need surgical intervention.

Part 2: Access Site Assessment: It was adopted from (Hyeon, et al., 2020): and used to assess local signs and symptoms of infection at access site, and scored as 0 or 1 as the following: 0 for absence of local signs of infection, and 1 for presence of local signs of infection.

Tool III- Critical-Care Pain Observation Scale: It was adopted from (Cheng et al., 2018 & Chookalayia, et al., 2018): composed of 12 items with 4 sections, each with different behavioral categories: facial expression, body movements, muscle tension, and compliance with the ventilator for intubated patients. Items in each section are scored from 0 to 2, with a total score ranging from 0 to 8.

Content Validity and Reliability:

Content validity was used for modifying tools and the designed protocol to determine whether the tools covered the study aim or not. It was evaluated by a

jury of seven experts; five nursing staff and two emergency and critical medical staff members. It was found that Cronbach's alpha reliability coefficient was "0.85, 0.88, 0.86, 0.89 and 0.87" respectively for "interviewing questionnaire for nurses, observational checklists, interviewing questionnaire for patient, vascular complications assessment questionnaire, and critical-care pain observation scale.

Administrative design:

Formal approval from the Research Ethics Committee of the Faculty of Nursing and the director of Zagazig University Hospital was obtained prior conducting the study. Meeting and discussion were held between the researcher and the nursing administrative personnel to make them aware about the aims and objectives of the research, as well as, to get better cooperation during the implementation phase of the study, also nurses and patients' consents were obtained before starting data collection. The reactions of the administrative personnel were very supportive for the study.

Field work:

The study was carried out through eight months from July 2022 to February 2023 where the researchers were available every day through the following phases:

Preparatory phase:

Researchers extensively reviewed the relevant literature and materials. Assessment of the nurse's knowledge and practice was conducted. The designed protocol was developed, identified needs, requirements and deficiencies were translated to aim of the study. In addition, teaching materials were prepared. The researchers created an illustrated booklet in Arabic language to assist nurses refreshing the information provided.

Implementation phase:

Data were collected in Neurological Intensive Care Unit of Accidental Hospital at Zagazig University Hospitals. The researchers contacted assigned nursing service administrators and assigned physicians at study setting daily to determine the number of newly admitted patients undergoing cerebral angiography. In addition to, measure the assessment time allocated before and after the designed protocol.

The questionnaire was filled through interviewing. The study aim was explained to critical care nurses before answering the questions. Researchers were available at morning and afternoon shifts. At the first, the researchers introduced themselves and started communication, explained the aim of the designed protocol and completed the interviewing questionnaire (tool I for nurses) to assess nurse's knowledge before the designed protocol and the observation checklist (tool II for nurses) was filled out by researchers to assess nurse's practice before designed protocol. Teaching sessions were scheduled

for theoretical and practical parts and the studied nurses were divided into subgroups, 4-5 nurses for each.

The designed protocol: included two parts:

First: Theoretical part:

Covered the meaning of cerebral angiography, indications, contraindications, types, complications, caring of patient before, during and after procedure, pain assessment and management, discharge instructions on access site home care such as dressing removal, physical activity, personal hygiene, and warning signs prior to discharge, therapeutic and dietary regimen, and follow up.

Theoretical contents were conducted through six sessions; time of each session was 15-30 minutes. Each nurse was provided with a booklet to assure understanding and clear any misconception or misunderstanding. Researchers continued to support the gained information, answer any questions and gave feedback. Communication channel between the researchers and the studied nurses was remained open.

The second:

The practical part: was covered the following procedures; care of patient after cerebral angiography if the patient was on mechanical ventilation, methods to control bleeding such as compression on access site, methods of infection control as hand washing and wearing glove and applying non pharmacological methods of pain control: such as patient's positioning, immobilization of affected limb, cold therapy, relaxation technique as muscle, respiratory, and meditation, dealing with bleeding and hematoma formation, and manual compression technique. In addition to, certain instructions given by critical care nurses to patients and his family before discharge such as; instructions to prevent hemorrhage, infection, and dietary and therapeutic regimen, warnings signs, and follow up. For practical part, each nurse's practice was evaluated before any procedure given (pretest) using the observational checklists (tool II for nurses).

Studied nurses were divided into subgroups, 4-5 nurses for each. Teaching conducted through 10 sessions; 30- 45 minutes for each. Demonstration and re demonstration carried out for each nurse. Each nurse was provided with a booklet and immediate posttest was done. Theoretical part was conducted in nursing office and practical part in clinical area. Teaching was given by many ways such as lectures, small group discussion, and problem solving situations. Teaching materials as posters, videos, and brochures were utilized.

Evaluation phase:

Each nurse was evaluated twice using the same data collection tools. This was done before the designed

protocol (pretest), and immediately after the designed protocol (posttest). Also, each patient was evaluated twice using tools designed for patients pretest and posttest to assess hematoma, access site assessment symptoms, and critical care pain observation to evaluate the effect of designed protocol on critical care nurses performance that reflected on improvement of patient's outcomes through reducing complications of cerebral angiography, access site symptoms, and pain.

Ethical consideration:

At the interview, each nurse and patient was informed about the purpose, benefits of the study, and they were informed that their participation is voluntary and they have right to withdraw from the study at any time without given any reason. In addition, confidentiality, and anonymity of the subjects were assured through coding of all data. No harm was expected from study implementation; conversely, the designed protocol had a positive impact on nurses' performance reflected on improvement of patient outcomes.

Pilot study:

It was conducted on 5 nurses and 5 patients to examine the tools for clarity, relevance, comprehension, understanding, applicability and ease of implementation. Data results helped in modifying tools, items were corrected or added as needed. Those who shared in the pilot study were excluded from the main study sample.

Statistical Design:

Collected data were coded, calculated and statistically analyzed using SPSS, version 22. Qualitative data were presented as frequency and percentages using Chi square (χ^2) for comparison of variables and Fisher Exact Test (FET). Quantitative data were presented as mean \pm SD, Paired t test used to compare between means of quantitative variables. Difference was considered significant at $P \leq 0.05$ and a highly significant at $P \leq 0.01$. Pearson correlation test (r) was used to test correlation between studied variables.

Results:

Table (1): Frequency Distribution of Demographic Characteristics for Studied Nurses (n=30)

Age	Mean± SD	30.23±8.45	
	Median (Range)	28.0 (23-55)	
Experience	Mean± SD	8.06±6.89	
	Median (Range)	5.0 (1-35)	
		N	%
Sex	Male	2	6.7
	Female	28	93.3
Marital	Married	26	86.7
	Single	4	13.3
Education	Diploma	7	23.3
	Diploma +specialty	15	50.0
	Bachelors	8	26.7
Training	Yes	6	20.0
	No	24	80.0
	Total	30	100.0

Table (2): Mean Scores of Nurses' Knowledge Pre and Post Designed Protocol

Items	Time	Mean	Std. Deviation	Paired t	P
Knowledge about cerebral angiography	Pre	7.466	4.538	-10.997	0.00**
	Post	17.600	2.206		
Knowledge nursing care for complications	Pre	1.000	1.259	-9.097	0.00**
	Post	3.533	.860		
Knowledge about home care	Pre	2.166	2.755	-5.991	0.00**
	Post	5.400	1.069		

** Highly Significant <0.001

Table (3): Mean Scores of Nurses' Practice Pre and Post Designed Protocol

Items	Time	Mean	Std. Deviation	Paired t	P
Immediate care post procedure	Pre	7.433	1.568	-10.851	0.00**
	Post	12.433	1.977		
Ongoing care	Pre	3.900	1.283	-16.068	0.00**
	Post	11.566	2.079		
Pain management	Pre	6.200	2.428	-17.317	0.00**
	Post	23.000	4.059		
Hematoma &bleeding management	Pre	9.833	1.683	-9.876	0.00**
	Post	15.366	2.566		
Care of access site	Pre	.7000	0.307	-10.434	0.00**
	Post	3.566	0.897		

** Highly Significant <0.001

Table (4): Correlations between Nurses' Knowledge and Practice

Items		Practice score
Knowledge score	r	0.774
	P	0.000**

** Highly Significant <0.001

Table (5): Distribution of Demographic Characteristics for Studied Patients (n=30)

Age			
Mean± SD		50.0±7.87	
Median (Range)		51.5 (35-65)	
		N	%
Sex	Male	26	86.7
	Female	4	13.3
Marital	Married	30	100.0
	Single	0	0.0
Residence	Rural	18	60.0
	Urban	12	40.0
Education	Illiterate	12	40.0
	Read and write	12	40.0
	Secondary	4	13.3
	High	2	6.7
Occupation	Manual worker	22	73.3
	Employee	6	20.0
	House wife	2	6.7
Smoking	Smoker	12	40.0
	Non	18	60.0
	Total	30	100.0

Table (6): Frequency Distribution of Past and Present History for Studied Patients (n=30)

Past history		N	%
Neurological disease	Stroke	10	33.3
	Subarachnoid hemorrhage	18	60.0
	Cerebral aneurysm	2	6.7
Vascular disease	No	4	13.3
	Atherosclerosis	10	33.3
	DM	16	53.3
Previous hospitalization	No	18	60.0
	Yes	12	40.0
Past surgery	No	24	80.0
	Yes	6	20.0
Allergy	No	30	100.0
	Yes	0	0.0
Present history			
Cardiovascular diseases	MI	2	6.7
	Hypertension	26	86.7
	Arrhythmias	2	6.7
Procedure	Diagnostic	10	33.3
	Intervention	20	66.7

Table (7): Frequency Distribution of Neurological Manifestation for Studied Patients (n=30)

Items	N	%
Headache	28	93.3
Seizers	6	20.0
Dizziness	10	33.3
Fainting	16	53.3
Tingling	12	40.0

Table (8): Frequency of Hematoma Pre and Post Designed Protocol (n=30)

Items		Pre		Post		P
		N	%	N	%	
Benign	No	30	100.0	30	100.0	0.002*
	Yes	0	0.00	0	0.00	
Small	No	6	20.0	24	80.0	0.09
	Yes	24	80.0	6	20.0	
Moderate	No	30	100.0	30	100.0	0.12
	Yes	0	0.00	0	0.00	
Large	No	30	100.0	30	100.0	1.0
	Yes	0	0.00	0	0.00	

* Significant <0.05

Table (9): Access Site Assessment Symptoms Pre and Post Designed Protocol (n=30)

Items		Pre		Post		P
		N	%	N	%	
Pain	No	0	0.0	26	86.7	0.00**
	Yes	30	100.0	4	13.3	
Redness	No	0	0.0	28	93.3	0.00**
	Yes	30	100.0	2	6.7	
Hotness	No	0	0.0	30	100.0	0.00**
	Yes	30	100.0	0	0.0	
Tenderness	No	0	0.0	28	93.3	0.00**
	Yes	30	100.0	2	6.7	
Swelling	No	0	0.0	26	86.7	0.00**
	Yes	30	100.0	4	13.3	

** Highly Significant <0.001

Table (10): Frequency Distribution of Critical Care Pain Observation Pre and Post Designed Protocol (n=30)

Items		Pre		Post		P
		N	%	N	%	
Facial expression	No muscle tension	8	26.7	26	86.7	0.00**
	Tense	22	73.3	4	13.3	
Body movement	Absence of movement	2	6.7	2	6.7	0.00**
	Protection	22	73.3	28	93.3	
	Restlessness	6	20.0	0	0.0	
Muscle tension	Relaxed	2	6.7	24	80.0	0.00**
	Tense, rigid	28	93.3	6	20.0	
Vocalization	Normal tone	12	40.0	24	80.0	0.00**
	Sighing, moaning	18	60.0	6	20.0	

** Highly Significant <0.001

Table (1): Reveals that the age of studied nurses was 23-55 years old with mean \pm SD 30.23 \pm 8.45 and their experience ranged between 1-35 years with mean \pm SD 8.06 \pm 6.89, and 93.3% of them were female and 86.7% were married. In addition half of studied nurses had diploma and specialty in nursing and only 20% of them had received training courses.

Table (2): Displays that mean scores of nurses' knowledge increased significantly after designed

protocol than before with a highly statistical significant difference (P=0.00).

Table (3): Illustrates that mean scores of nurses' practice improved significantly after designed protocol than before with highly statistical significant difference (P=0.00).

Table (4): Outlines that there was a strong positive correlation between nurses' knowledge and their practice with a highly statistical significant difference (P=0.00).

Table (5): Clears that age of studied patients ranged between 35- 65 years old with mean \pm SD 50.0 ± 7.87 . Also, all studied patients were married and 86.7% were male, 60% were from rural area, 40% were illiterate and read and write. In addition, 60% were not smokers.

Table (6): Summarizes that 60% of studied patients had subarachnoid hemorrhage and 53.3% were diabetic. Also, 86.7% were hypertensive and 66.7% had interventional cerebral angiography.

Table (7): Clarifies that 93.3% of studied patients had headache and 53.3% had fainting.

Table (8): Explains that 80% of studied patients had small hematoma before designed protocol which decreased to 20% after designed protocol.

Table (9): Reveals that, there was a highly statistical significant improvement in access site assessment symptoms after designed protocol.

Table (10): Displays that there was a significant decrease in pain through improvement of facial expression, body movement, muscle tension, and vocalization after designed protocol.

Discussion

Regarding demographic characteristics of study nurses, the result of this study revealed that the ages of studied nurses were ranged from 23 to 55 years old with mean \pm SD 30.23 ± 8.45 . In addition, the most studied nurses were female. This finding might be due to the studying of the nurses in Egyptian universities exclusive for girls only till a few years ago. Concerning years of experience the finding of this study illustrated that years of experience for studied nurses ranged from 1 to 35 years with mean \pm SD 8.06 ± 6.89 . Also, half of studied nurses had diploma and specialty in nursing. This finding might illuminate the current condition of nursing qualification. Moreover, only 20% of study nurses had received training courses.

This finding was in consistent with **Yang et al., (2021)** who found that the majority of the nurses under study were females. In the same line with **Abdulmiem et al., (2023)** who found that 41% of studied nurses had more than 15 years of experience. Similarly with **Mahendra et al., (2021)** who found that more than half of the study nurses had diploma nursing. In congruent with **Abd El-Hay, et al., 2018** who illustrated that the majority of study nurses have no previous training programs. Conversely with **Ram (2019)** who stated that most of the study nurses were less than 30 years old. Also the result disagreed with **Haroon (2021)** who outlined that more than half of nurses (54.3%) had baccalaureate degree.

Concerning nurses' knowledge, study result revealed that mean nurses' knowledge scores increased significantly after designed protocol with a highly

statistical significant difference. This indicated that, it was necessary to improve nurses' knowledge regarding cerebral angiography to support practical skills toward improved outcomes of patients with cerebrovascular accidents disease, as improving performance in ICUs would minimize morbidity rate and improve quality of patient care.

This result agreed with **Naga et al., (2021)** who reported the same results. On the same line with **Kousar et al., (2022)** who mentioned that there was significant improvement in nurses' knowledge and practice about care of stroke patients after training program. On contrary with **Mahendra et al., (2021)**, who stated that more than 75% of study nurses had inadequate knowledge.

Regarding nurses' practice, study finding illustrated that there was a statistical significant improvement of nurses' practice regarding immediate post care, ongoing care, pain management, hematoma & bleeding management, and care of access site after the designed protocol. This necessitates the importance of conducting continuous in-service designed protocol and updated clinical training programs for critical care nurses regarding care of patients undergoing cerebral angiography. This result was in congruent with **Ge & Wei (2020)** who reported that there was statistically significant improvement in nurses' practice regarding patient assessment by using Glasgow Coma Scale (GCS) after program. Conversely with **Abd Elmegeid, et al., (2020)** who showed that most of studied nurses had inadequate practice toward airway, breathing, circulation, disability and assessment of patients with cerebral stroke at the first golden hours.

The study results revealed that there was a strong positive correlation between nurses' knowledge and their practice with a statistical significant difference. Thus, the designed protocol led to better knowledge, which in turn led to better practice. This finding was in consistent with **Gomaa, et al., (2019)** who indicated that there was a positive correlation between nurses' knowledge and practice toward care of patients with cerebral stroke.

Concerning the demographic characteristics of studied patients. The study results clarified that age of studied patients was 35- 65 years old with mean \pm SD 50.0 ± 7.87 . This result was inconsistent with **Wong et al., (2022)** who stated that the mean age of patients was 49.7 years and 61.2% were male. On the same line with **Wan, et al., (2022)** who found that age of studied groups was 51 years. On contrary with **El Gendy, et al., (2019)** who found that age of studied groups was greater than 65 years old.

The study finding clarified that all patients were married and the majority of them were male. This finding was supported by **Ammad, et al., (2018)** who

found that the majority of the studied patient received cerebral angiography were males. Similarly with **Ahmadkhani et al., (2018)** who found that more than three quarters of patients in intervention group and more than half of patients in control group were male and married.

The result of this study revealed that more than half of studied patients were from rural area and less than half of them were illiterate and read and write. In addition, more than half of study patients were not smokers. In the same line with **Osun et al., (2020)** who found that 50% of patients were illiterate, about 50% of them were from rural area. Also the majority were not smokers.

Concerning patients past history, the study finding clarified that two third of studied patients had subarachnoid hemorrhage, followed by stroke (33.3%). This means that ischemic or hemorrhagic mechanisms have to be documented before any treatment. This result was agreed with **Baig et al., (2018)** who illustrated that the most common indications of cerebral angiography were subarachnoid hemorrhage (30.8%), followed by stroke (26.6%) and arteriosclerotic vascular disease (23.1%).

As regards patient present history, the majority of patients under study were hypertensive and nearly two third had interventional cerebral angiography. This result supported by **El Gendy et al., (2019)** who found that hypertension was most common in control and study group. This finding was in disagreement with the study of **Sayadi, et al., (2018)** who outlined that recurrent ischemia was the most common in studied patients.

Concerning neurological manifestation, the study results indicated that the most of study patients had headache and more than half had fainting. Similarly with **Hoffman, et al., (2022)** who illustrated that, the majority of patients complained from headache and dizziness. On the same line with **Stone et al., (2020)** who found that nearly half of patients in control and study group suffered from vomiting and fainting.

Regarding hematoma formation the study finding revealed that there was a significant decrease in hematoma formation after designed protocol. This may be due to the significant positive effect of the designed protocol on improvement of nurses' knowledge and practice which reflected then of improvement of patients' outcomes through minimizing complication and ongoing improvements in quality of care.

This result was in consistent with **El Gendy et al., (2019)** who found that nearly one quarter of patients in control group, compared to only 6.7% of patients in study group had small hematoma immediately post procedure. Similarly with, **Wan et al., (2022)** who

clarified that the utilized activities for patients undergoing interventional angiography reduce incidence of major complications after practice guidelines. In consistent with **Stone et al., (2020)** who stated that there was a significant reduction in systemic and neurosurgical complications after application of nursing educational program.

The study result illustrated that there was a statistical significant decrease in access site symptoms after designed protocol. This result was in congruent with **Greco Hiranaka, et al., (2021)** who found that applying cold compresses decrease pain at vascular access site. On the same line with **Vincent et al., (2022)** who revealed that there was a statistical significant reduction in pain at sheath removal in study group than in other.

Regarding critical care pain observation the study finding indicated that there was a significant decrease in pain through improvement of facial expression, body movement, muscle tension, and vocalization after designed protocol. This result was in consistent with **Dalai, et al., (2022)** who stated that nearly more than one-third of patients had little such as mobility loss and problems of speech and above one quarter had problems in vision.

Conclusion:

There was a significant improvement of critical care nurses' knowledge and practice after the designed protocol, which reflected then on improvement of patients' outcomes through reduction of postoperative complications for patients undergoing cerebral angiography and pain improvement.

Recommendation:

- Continuous training program should be applied for critical care nurses regarding care of patients undergoing cerebral angiography for updating their knowledge and practice.
- Effective departmental policies and procedures are recommended for nursing staff regarding care of patients with cerebral angiography.
- Further study with replication of this study on larger probability sample is recommended to achieve generalization of the results and wider utilization of the designed protocol.

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Conflict of interest: No

Author contribution:

The first author participated in designing data collection tools, translation of tools and booklet into Arabic, statistical analysis, comments on the result tables, participated in the references collection, and administering the designed protocol. The second author participated in data collection, provided pre

and posttest, applied the designed protocol to critical care nurses, preparation of videos, colored brochure and posters, participated in the references collection and data analysis.

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