Effectiveness of Post-Operative Nursing Care Protocol on Nurses' Performance and Health Outcomes among Brain Surgeries Patients

Rawia Ali Ibrahim [1], Fatma Mohamed Attia [2], Nora Fares Mohamed [3]

[1] Assistant Professor of Medical Surgical Nursing, Faculty of Nursing, Benha University, Egypt.
[2,3] Lecturers of Medical Surgical Nursing, Faculty of Nursing, Benha University, Egypt.

Abstract

Background: Nursing care after brain surgery requires vigilant detailed patients' monitoring and management to ensure neurological and systemic stability that enhances safe and effective recovery. **Study' Aim:** to evaluate effectiveness of post-operative nursing care protocol on nurses' performance and health outcomes among brain surgeries patients. **Methods:** The study used **a quasi-experimental design** specifically employing a pre/post-test that conducted in the neurosurgical post-operative care units at Benha University Hospital. **Convenience sample** of 50 nurses and **purposive sample** of (66) adult patients were involved in this study. **Tools: (I)** Nurses' Self-Administered Questionnaire, **(II)** Nurses' Practice Observational checklist **(III)** Patient' health outcomes assessment sheet. **Results:** only10.0% of the studied nurses had satisfactory level of knowledge pre nursing care protocol implementation compared to 80.0% & 76.0% respectively at immediate and post three months of implementation. As well as, only16.0% of the studied nurses had adequate level of practice pre nursing care protocol implementation compared to 82.0% &80.0%, respectively at immediate and post 3 months of implementation. In addition, there were statistically significant differences between patient groups (pre/ post protocol implementation group) regarding severity of complications immediately post operative and on discharge than before. **Conclusion:** post-operative nursing care protocol effectively improved nurses' knowledge, practices, and health outcomes among brain surgery patients. **Recommendation**: Conduction ongoing educational programs for nurses regarding rehabilitation and functional recovery of brain surgery patients is necessary.

Key words: Brain Surgery, Health Outcomes, Nurses' Performance, Post Operative Care Protocol

Introduction

Brain surgery encompasses a range of surgical procedures aimed at treating structural abnormalities, injuries, tumors, aneurysms, or other conditions affecting the brain and surrounding tissues. These procedures are often complex and require a high level of precision due to the delicate nature of the central nervous system and its vital role in regulating bodily functions. Advances in neuroimaging, microsurgical techniques, and intraoperative monitoring have significantly improved surgical outcomes and patient survival **(Chen et al., 2024)**.

The most common types of brain surgeries are craniotomy where a portion of the skull is temporarily removed to access the brain for tumor removal or hematoma evacuation. Minimally invasive endoscopic brain surgery uses small incisions and specialized instruments to treat conditions such as hydrocephalus. Stereotactic surgery involves precise, computer-guided navigation to treat deep-seated lesions or perform biopsies. Deep brain stimulation is used primarily for movement disorders like Parkinson's disease. Awake brain surgery allows the surgical team to monitor the patient's cognitive and motor functions in real-time especially during operations. Each surgical approach comes with specific risks and post-operative care needs **(Salmon & Davis, 2022)**.

Primary indications of surgery are the presence of brain tumors that disrupts normal brain activity, traumatic brain injuries (TBI) such as hematomas and skull fractures. Other common indications include intracranial aneurysms where surgical clipping or resection is needed to prevent hemorrhagic stroke. Hydrocephalus which is a condition characterized by the accumulation of

cerebrospinal fluid, often necessitates the placement of a shunt. Additionally, epilepsy that is resistant to medication may be treated surgically through lesion removal or resection of seizure foci. In each of these cases, timely and appropriate surgical intervention can significantly improve prognosis and enhance quality of life **(Kamp et al., 2022)**.

Several contraindications must be carefully considered before proceeding with neurosurgical intervention including severe systemic illnesses such as uncontrolled cardiac, pulmonary, or renal disease that may increase the risk of anesthesia-related complications. Poor neurological status such as those with widespread brain damage may render surgery futile additionally, coagulopathies due to the potential for uncontrollable hemorrhage, until being corrected prior to the procedure. Patients with advanced malignancies or terminal illnesses when surgery would not meaningfully extend life or improve function. Other relative contraindications include severe infection, poor nutritional status, and lack of caregiver support, which can complicate post-operative outcomes **(Zeiler et al., 2023)**.

The most common complications associated with brain surgery are intracranial bleeding, increased intracranial pressure, and potentially life-threatening brain herniation. Meningitis or surgical site infection is another concern, especially when implants such as shunts are involved. Neurological deficits, such as speech disturbances, vision problems, or cognitive impairments, result from direct injury to functional brain areas during surgery. Seizures are also a known post-operative complication after tumor resections or cortical surgeries. Other complications include cerebrospinal fluid leaks, brain swelling, deep vein thrombosis and respiratory issues **(Kulikov et al., 2022)**.

Nurses act as the frontline caregivers responsible for post-operative management for brain surgery patients. Therefore, developing post-operative nursing protocol plays a critical role in early detection and minimizing long-term consequences. In the immediate post-operative phase, nurses should perform frequent neurological assessments using tools such as the Glasgow Coma Scale (GCS) to monitor changes in consciousness, motor response, and pupil reactivity. They are also responsible for monitoring vital signs, managing intracranial pressure (ICP) devices, and ensuring airway patency. Preventing secondary brain injury, pain management, seizure prevention, and infection control are also essential aspects of post-operative care that require vigilant nursing intervention. Additionally, nurses provide emotional support, facilitate early mobilization, and educate patients and families about post-surgical expectations and rehabilitation. Therefore, structured post-operative care protocols and ongoing training are essential to empower nurses in providing high-quality, evidence-based neuro care **(Wang et al., 2024)**.

Significance of the Study

Traumatic brain injuries and neurological disorders that require brain surgery are among the leading causes of death and disability worldwide. According to the World Health Organization, an estimated 69 million individuals suffer from TBI globally each year, with severe cases often requiring neurosurgical intervention. In addition, brain tumors, stroke, and congenital anomalies contribute significantly to the global burden of neurosurgical disease. As brain surgeries become more common

due to advances in medical imaging and surgical techniques, the quality of post-operative nursing care plays a pivotal role in determining patient outcomes. Poor post-operative management can lead to increased rates of complications such as infection, bleeding, seizures, and prolonged hospitalization. Nursing protocols can reduce complications, shorten hospital stays and improve neurological recovery **(James et al.,2025)**.

In Egypt, traumatic brain injuries (TBIs) represent a major public health challenge, particularly among young males. A study at Cairo University Hospital reported 844 cases of moderate to severe TBI accounting for 17.2% of all head trauma admissions during sampled months; falls and motor vehicle collisions were responsible for approximately **64%** of injuries **(Elfeky et al.,2024)**. Adult brain surgeries are frequently performed, with a notable incidence of brain tumors are found in neurosurgery department **(Mohamed et al., 2021**). **At Benha University Hospital,** the total number of brain surgery patients admitted at neurosurgery at the last two years (2023&2024) were approximately (90& 80) patients respectively due to brain tumor or TBIs, so there is need for structured post-operative nursing protocols to improve neurosurgery nurses' performance post-operative and patients' outcomes (**Medical Registration and Statistics Office Benha university, 2024).**

Subjects and methods

Aim of the study:

This study aimed to evaluate effectiveness of post-operative nursing care protocol on nurses' performance and health outcomes among brain surgeries patients.

Research hypotheses:

To achieve the aim of this study, the following hypotheses were formulated:

H1: Nurses' knowledge score regarding care of brain surgeries patients could be higher after implementing post-operative nursing care protocol.

H2: Nurses' practice score regarding care of brain surgeries patients could be higher after implementing post-operative nursing care protocol.

H3: Patients' health outcomes could be significantly improved after implementing post-operative nursing care protocol.

Operational definitions:

Nurses 'performance refers to nurses' level of knowledge and practice.

Health outcomes involve clinical risk score, neurological status stability level, headache intensity, and complications severity.

Research design: A quasi-experimental research design (pre/post-test) was used in this study.

Variables: the independent variable is post-operative nursing care protocol. While the dependent variables are nurses' performance, and health outcomes.

Setting:

This study conducted in the neurosurgical post -operative care units which locates at the 5th floor of Benha University Hospital building consisting of four rooms (one as a critical care unit where patients admitted during 24 hours post -surgery and other three rooms as inpatient units). Each room has four beds.

Subjects: Two groups of subjects were recruited in this study as follows:

- **Convenience sample** of all available nurses (50) during data collection period.
- **Purposive sample** of (66) adult patients with brain surgery who divided into two groups:
  - Pre nursing care protocol implementation group (33 patients) who received nursing

care before implementing nursing care protocol.

- Post nursing care protocol implementation group (33 patients) who received nursing care after implementing nursing care protocol.

Sample Size:

Utilizing the Epi Info (7) statistical software, the sample size was determined at a 95% confidence level with a permissible margin of error of 5%, referencing the admission data from the neurosurgical post-operative care unit at Benha University Hospital for the previous year (2024). A total sample size of 66 patients was identified.

Data collection tools:

Three tools for data collection were used as follows:

Tool I: Nurses' self-administered questionnaires. It was designed by the researchers, based on reviewing recent and related literatures (**Burkhart et al., 2011; Haussalo, 2021& Mostafa et al., 2023)** and written in Arabic language. It aimed to assess nurses' knowledge regarding care of patients undergoing brain surgeries consisting of two parts:

Part 1: Personal characteristics of nurses as: age, gender, marital status, qualification, years of experience in neurosurgery and attendance of previous training courses regarding brain surgeries.

Part 2: Nurses ' knowledge assessment sheet that includes five sections as each section composed of Multiple-Choice Questions to assess nurses' knowledge regarding:

I) anatomy and physiology of brain and included (9) questions

II) types of brain surgeries and included (10) questions

III) indications and contraindications of brain surgeries and included (10) questions.

IV) complications and risks associated with brain surgeries and included (5) questions.

V) post -operative nursing care (42 questions) that distributed to 10 sub items as follows:

1- Physiological and hemodynamic monitoring (9 questions)
2- Increased intracranial pressure management (4 questions)
3- Seizures management (3 questions)
4- Pain management (4 questions)
5- Medication administration (4 questions)
6- Wound assessment for bleeding or infection (6 questions)
7- CSF leakage signs and management (4 questions)
8- Nutrition (2 questions)
9- DVT prevention (2 questions)
10- Physical and emotional support (4questions)

Scoring system:

Each correct answer was given one degree and the incorrect answer was given zero. The total score of knowledge was 76 degrees equal (100%). Total score of knowledge summed up and distributed as follows:

- **Satisfactory level of knowledge** ≥ 80% that equal or more than 61 degrees
- **Unsatisfactory level of knowledge** < 80% that less than 61 degrees

Tool II: Nurses ' practice observational checklist. It was adapted from **(Hickey, 2020; Thomas, 2020&Yousef et al., 2021).** It aimed to assess nurses ' practice regarding care of brain surgery patients postoperatively that included 10 main items:

1-**Immediate care** (43 steps) as: (ABC assessment, correct positioning, connecting pulse oximeter, connecting cardiac monitor, and neurological monitoring using GCS)

2- **Respiratory care** (oxygen therapy & suctioning as needed) (18 steps).
3-**Hemodynamic monitoring** (56 steps) includes: (Vital signs, CVP measurement, ABG s sample and blood glucose level).
4- Nasogastric feeding (11steps)
5-Fluid and electrolytes balance (5steps)
6-Pain management (4 steps)
7-Warning signs monitoring and management (22steps)
8-Infection control measures (34 steps)
9- Deep Venous Thrombosis prophylaxis (7 steps)
10-Discharge instructions (17steps).

Scoring system: The total score for all items was 217 degree (100%), the practice steps observed to be done correctly were scored (1), the steps incorrectly done or not done were scored (0).

- If the practice total score was ≥ 80 %, it could be **adequate level of practice** (≥ 174 degrees).
- If the practice total score was < 80%, it could be **inadequate level of practice** (< 174 degrees).

Tool III: Patients' health outcomes assessment sheet:

It was designed by researchers after reviewing related and recent literature including six parts as the following:

Part one: Personal data of studied patients as: age, gender, level of education and residence.

Part two: Patient' clinical data as: diagnosis, previous neurological surgery, previous neurological complain, type of performed surgery and comorbidity.

Part Three: Clinical risk score using National Early Warning Score (NEWS) that adopted from **(Moore& Cunningham, 2021).** In which physiological parameters (respiration, oxygen saturation, blood pressure, pulse rate, temperature and AVPU level of consciousness were assessed and score of 0, 1, 2 or 3 is allocated to each parameter. A higher score means the parameter is further from the normal range. Appropriate clinical responses are given for threshold levels

- **Low risk** (aggregate score 1 to 4)
- **Moderate risk** (5-6 score)
- **High risk** (aggregate score of 7 or over)

Part Four: Neurological status stability Assessment using Glasgow coma scale plus that adopted from **(Waterhouse, 2020 & Bertotti et al.,2023).** this scale combines level of consciousness with pupil reactivity that reflects brain stem reflexes**.** In which patient assessed for level of consciousness using GCS as follows:

- 13-15= fully responsive (patient is awake, mildly confused, obey commands and communicate)
- 9-12 = impaired consciousness (patient is drowsy, confused, open eyes and can localize pain)
- Less than or equal 8= coma (unresponsive, requires intubation and intensive care)

In addition, the patient assessed for pupil reactivity as follows:

- 0 = both pupils reactive
- 1 = one pupil unreactive
- 2= both pupils unreactive

Scoring System: Glasgow Coma Scale Plus score defined by subtracting the pupil reactivity score from the total GCS score and interpreted as follows:

- 13-15= more stable neurological status
- 9-12 = impaired neurological status
- Less than or equal 8= worse neurological status

Part Five: Headache Intensity Assessment Using Numeric Pain Rating Scale adopted from **(Puntis & Garner, 2015).** It considered as indicator of complications including wound infection, increased ICP and cerebrospinal fluid leakage and scored as: Mild (1-3), Moderate (4-6), severe (7-10). In addition, headache characteristics as type and methods of relieving (Pharmacological or non-pharmacological) also assessed

Part six: Complications Severity Assessment using Landriel Ibañez classification score that adopted from **(Nanda,2019& Ibañez et al.,2021)** involving:

- **Grade I (Mild)** denote complications that required minor intervention or monitoring as (a mild postoperative headache, minor wound infection that requires antibiotics and local wound care, electrolyte imbalance and fever that can be managed by antipyretics).
- **Grade II (Moderate)** denote complications that required pharmacological or surgical intervention as (hematoma requiring reoperation for evacuation, increased ICP that require frequent lumbar puncture or shunt drain, wound Infection required frequent care, seizures, DVT and CSF leakage).
- **Grade III (Severe)** denote complications that required prolonged hospitalization or readmission to neurosurgery ICU as (Massive cerebral edema, bleeding, neurological deficits and sepsis).

Post-Operative Nursing Care Protocol It was designed by the researchers based on educational needs of the nurses that was acquired during the pretest phase. It was written in Arabic language and had colorful illustrations covering both theoretical and practical aspects to enhance nurses' capacity for learning.

- **Theoretical part** contained anatomy and physiology of brain, types of brain surgeries, indications and contraindications, complications and risks associated with brain surgeries and post -operative nursing care for brain surgeries patients.
- **Practical part** included :Immediate care post-operative as : ABC assessment , correct positioning, connecting pulse oximeter, connecting cardiac monitor, and neurological monitoring using GCS), respiratory care, hemodynamic monitoring includes vital signs, CVP measurement, ABG s sample and blood glucose level, nasogastric feeding, fluid and electrolytes balance ,pain management ,warning signs monitoring and management, infection control measures ,DVT prophylaxis and discharge instructions.

Method

Administrative design and Ethical consideration:

An official permission was granted from the Dean of Faculty of Nursing, Benha University, hospital directors, and head of the neurosurgery department at Benha University Hospital. The researchers received permission to collect data. The nature and goals of the study were described, allowing it to be carried out without any opposition. Approval to conduct the study given by Scientific Research and Ethics Committee of the Faculty of Nursing at Benha University **(REC-MSN-P82).** The study sample received an explanation of the study's purpose,

further verbal consent was obtained for study participation, and study groups were made aware that they might leave the study at any moment prior to its completion. Additionally, they received assurances that the data collected would be confidential and utilized exclusively for the study purpose.

Content validity and reliability: The tools' content was validated by a panel of five specialists from the medical-surgical nursing department, Faculty of Nursing, Benha University. Experts' assessments of the content's applicability, thoroughness, and sentence clarity guided the modifications.

The reliability of knowledge assessment sheet, observational checklist and patient' health outcomes sheet was evaluated using Cronbach's alpha test; the results showed values of 0.88, 0.89, and 0.84 correspondingly, indicating good reliability.

Pilot study: To test the tools, a pilot study involving 10% of the study participants (5nurses and 6 patients) was conducted. In order to estimate the amount of time needed for data collecting, this was done to test the study process's clarity, applicability, practicality, and tool relevance. Modifications were made based on pilot study' results. Consequently, participants in pilot study were excluded from study sample

Field of work: The data collection process lasted eight months, starting in November 2024 and ending in June 2025. The study was carried out through four phases: preparatory and assessment, planning, implementation, and evaluation.

The preparatory and assessment phase:

Preparatory phase included reviewing the available literature and studies pertaining to the research problem and theoretical knowledge through textbooks, evidence-based articles, internet periodicals, and journals.

Assessment Phase:

For Nurses: The researchers visited the neurosurgical post -operative care unit three days weekly (morning & afternoon) to collect the data by using previous tools. The researchers interviewed with the available nurses, Average of 4-5 nurses were interviewed per/day. At the beginning of the interview, the researchers greeted nurses and explained the nature, aims and expected outcomes of the study and take their consent to participate in the study prior to data collection, then the researchers assessed the nurses' knowledge and practice level regarding caring for patients undergoing brain surgeries by using nurses' self-administered questionnaire and nurses' practice observational checklist (Tools I and II). This interview took about 35-45 minutes.

For patients: The researcher collects personal and clinical data of pre nursing care protocol implementation group from records using (tool III part 1&2) then, they were assessed the patients' health outcomes as clinical risk, neurological status, headache intensity, postoperative complication and its severity using **(Tool III part 3,4,5&6)**. It was assessed two times (immediately post-surgery and at discharge).

Planning phase:

Researchers designed post -operative nursing care protocol based on the needs assessment of nurses, a review of the literature, own experiences, and expert comments. The researchers constructed an instructional booklet in Arabic that included both theoretical and practical parts. The number of sessions, their content, and several teaching methods such as lectures, group discussions, demonstrations, and

re-demonstrations for practical nursing skills. In addition, Training media included were a booklet, images, videos from a laptop or mobile. PowerPoint presentation was also used.

Implementation Phase:

This phase was achieved through sessions at a period of 2 weeks for each sub group of nurses. This phase took a period of five months. Every session began with an overview of the previous one and the goals for the current one. Considering that the Arabic language is used in a way that is appropriate for the educational level of the nurses. The total numbers of sessions were six. It was separated into two knowledge sessions and four practice sessions. Knowledge sessions lasted from forty-five to sixty minutes. The nurses divided into groups of (4-5nurses) in order to acquire the related information. Each nurse was supplemented with postoperative nursing care protocol booklet. The researcher continued to reinforce the gained information, answered any raised questions and gave feedback. The duration of practical sessions lasted for forty- five to sixty minutes, and numbers of sessions were four sessions for each group in the form of demonstration and re-demonstration.

Evaluation phase:

For nurses: The researchers evaluated the effect of post-operative nursing care protocol on their performance using the same tools of pretest two times, immediately and post 3months.

For patients*:* The researchers collect personal and clinical data of patients who received care by nurses who involved in program (post protocol group) from records using (Tool III part 1&2). After that, they assessed for health outcomes involving clinical risk, neurological status, headache intensity, postoperative complication and its severity using the same tool for pre implementation group **(Tool III part 3,4,5&6)**. It was assessed two times (immediately post-surgery and at discharge).

Statistical analysis of the data

Data were verified prior to entry into the computer. The Statistical Package for Social Sciences (SPSS version 21) was used for that purpose, followed by data analysis and tabulation. Numerical data were expressed as mean and standard deviation. Qualitative data were expressed as frequency and percentage. Chi-square test was used to examine the difference between qualitative variables. The statistical tests were used as Paired (t) test was used to compare mean scores between the same sample at different study phases while Chi square was used for number and percent distribution, while the Spearman correlation test (r) was used to determine correlations between the study variables across various study phases. A highly significant level value was considered when $p \leq 0.001$, while a significant level value was considered when $p \leq 0.05$, and insignificant when $p > 0.05$.

Results:

Table 1: reveals frequency and percentage distribution of studied nurses according to their personal data. It shows that the age of 54.0% of the studied nurses was 20 to <30 years with a mean age of 28.60± 6.30. Concerning gender, 76.0% of the studied nurses were females and married. As for qualification, 50.0% of the studied nurses had nursing technical nursing institute.34.0% % of them had 1 to <5 years of experience in neurosurgery department with a mean 6.22 ± 3.55 and 66.0% of nurses reported not have any training courses related to care of patients with brain surgeries.

Table 2: Shows difference between

total mean of nurses' knowledge about brain surgeries and post-operative nursing care during study phases .it reveals that there was a highly statistically significant differences regarding total mean of nurses' knowledge between pre and post nursing care protocol implementation periods, while the total mean score of knowledge was 38.88±8.86 pre nursing care protocol implementation which increase to 65.78±8.96 post nursing care protocol implementation and slightly declined to 62.04±8.77 post 3 months of nursing care protocol implementation.

Figure (1): Displays difference between nurses' total knowledge level about brain surgery and post -operative nursing care throughout study phases.It demonstrates that, only10.0% of the studied nurses had satisfactory level of knowledge regarding brain surgeries and nursing management pre nursing care protocol implementation compared to 80.0% & 76.0% respectively at immediate and post three months of implementation with statistically significant difference within study phases as p value at (0.001,0.024) respectively.

Table (3) Shows difference between total mean of nurses' practices regarding post -operative nursing care of patients with brain surgery. It illustrates total mean score of nurses' practices was 120.28±21.46 pre nursing care protocol implementation which increase to 182.60±29.33 post nursing care protocol implementation and slightly declined to178.16±26.48 post 3 months of nursing care protocol implementation with a highly statistically significant differences regarding most items of nurses' practices between pre and post nursing care protocol implementation periods at $p \leq 0.001$.

Figure (2) Displays difference between nurses' total practice level regarding post -operative care of brain surgery patients throughout phases of Study. It shows that, only16.0% of the studied nurses had adequate level of practices pre nursing care protocol implementation compared to 82.0% &80.0%, respectively of them at immediate and post 3 months of nursing care protocol implementation with significant statistical difference as p value $p \leq 0.05$.

Table (4) Demonstrates correlation between total knowledge and practice among studied nurses pre and post periods of nursing care protocol clarifying that there was a positive and highly significant correlation between total nurses' knowledge with their total practice immediate and post 3 months periods of nursing care protocol implementation with p-value of ($<0.001^{**}$), while there was no significant correlation ($p=0.44^{n.s}$) pre protocol implementation.

Table (5) Illustrates comparison between pre and post nursing care protocol group of studied patients regarding their personal data. It shows that 45.5%, & 48.5% respectively of pre and post protocol group of studied patients their age was from 40 to less than 50 years old. Also, 75.8& 66.7% of both groups were males. Regarding educational level 48.5% & 39.4%% of them had intermediate education and54.5% &51.5% of them had manual works. Also,63.6% & 60.6 %, were from rural areas, there was no statistical significance difference between both groups with p value > 0.05 which indicates that the two groups were nearly homogenous

Table (6). Displays comparison between pre and post nursing care protocol group of studied patients regarding their medical data. It reveals that 36.4% & 48.5% respectively of pre and post protocol group of patients diagnosed with subdural-hematoma. and 60.6% &69.7% of both groups

didn't perform previous neurological surgeries. As regards Previous Neurological complain72.7% & 66.7% of both groups complain from headache respectively. Related to type of surgery 63.6%% 60.65%of pre and post group performed craniotomy. Concerning comorbidity, 54.5% and 57.6% of both groups had hypertension. There was no statistical significance difference between both groups with p value > 0.05 which indicates that the two groups were nearly homogenous.

Table (7). States comparison between pre and post nursing care protocol group of studied patients according to their clinical risk score immediately post operative and at discharge. It clarifies that, immediately post-operative, 36.3% of pre nursing protocol group of patients had high risk compared to 60.6% of post nursing protocol group had moderate risk. While, at discharge, 60.6% of pre nursing protocol group had moderate risk where as 57.5% of post nursing protocol group had low risk. it was noted that there were statistically significant differences between clinical risk score for both groups as p value <0.05.

Table (8). Shows comparison between pre and post nursing care protocol group of patients according to their neurological status stability immediately post-operative and at discharge. It reveals that 48.4% of pre nursing protocol group had worse neurological status compared to 42.2% of post nursing protocol group who had impaired neurological status immediately post-operative. While at discharge 45.5% of pre nursing protocol group had more stable neurological status where as 78.8% of post nursing protocol group had more stable neurological status. Also, there were statistically significant differences between neurological status for both groups as p value <0.05.

Table (9) Illustrates Comparison between pre and post nursing care protocol group of patients according to their headache intensity and characteristics immediately post - operative and at discharge. IT reveals that 60.6% &51.5% of pre nursing protocol group had severe headache and chronic type Immediately post-operative compared to 48.5%& 72.7 % of post nursing protocol group respectively. While, at discharge 69.7% of pre nursing protocol group had more moderate headache, where as 57.6% of post nursing protocol group had mild headache. Also, there were statistically significant differences between both groups at discharge as p value <0.05.

Figure (3). Clarifies comparison between pre nursing care protocol group and post nursing care protocol group of patients regrading postoperative complications immediately post operative. It shows that 54.5% ,45.5%&51.5% of pre nursing protocol group had headache, hematoma and neurological deficit respectively immediate post operative compared to 42.5%,18.2% &30.3% respectively of post nursing protocol group.

Figure (4). Clarifies comparison between pre nursing care protocol group and post nursing care protocol group of patients regrading postoperative complications at discharge. It shows that 39.4%&45.5%f pre nursing protocol group had headache and neurological deficit respectively compared to 18.2% &21.2% respectively among post nursing protocol group.

Table (10). Shows comparison between pre and post nursing care protocol group of patients regarding complications severity immediately post- operative and at discharge. It displays that 54.5% of pre nursing protocol group had moderate

complication while 45.5% of post nursing protocol group had mild complication immediate post - operative. While, at discharge 39.4% of pre nursing protocol group had mild complication compared to 75.8% of post nursing protocol group. Additionally, there were statistically significant differences between the two groups in terms of the severity of complications immediately post-operative and upon discharge ($p < 0.05$).

Table (1): Frequency Distribution of Studied Nurses According to Personal Data (n = 50).

Items	The studied nurses (n=50)	
	N	%
Age (Years)		
< 20	6	12
20 - <30	**27**	**54**
30 - < 40	15	30
40-50	2	4
Mean ± SD 28.60± 6.30		
Gender		
Male	12	24
Female	**38**	**76**
Marital Status		
Unmarried	12	24
Married	**38**	**76**
Qualification		
Diploma in nursing	9	18
A technical nursing institute	**25**	**50**
A bachelor's degree in nursing	13	26
Postgraduate studies	3	6
Experience years in neurosurgery		
< 1	6	12
1 < 5	**17**	**34**
5 < 10	19	38
≥ 10	8	16
Mean ±SD 6.22 ± 3.55		
Attendance of any training course related to care of patients with brain surgeries		
Yes	17	34
No	**33**	**66**

Table (2): Difference between Total Mean of Nurses' Knowledge About Brain Surgeries and Post Operative Nursing Care (n=50).

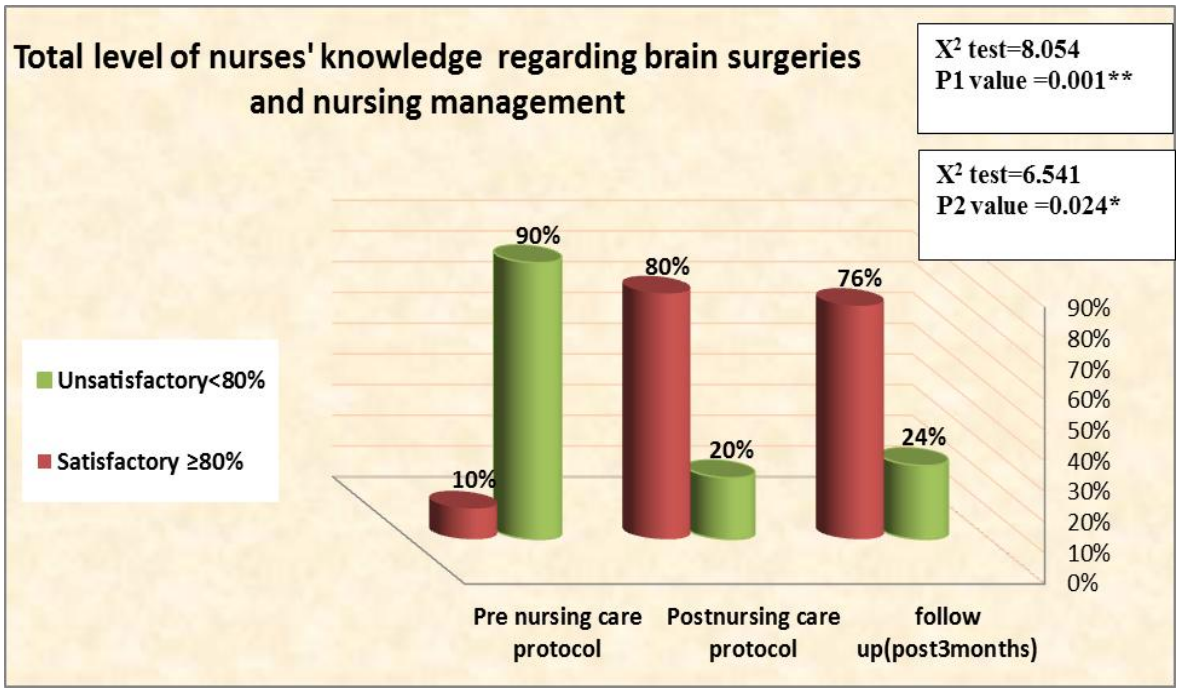
Total nurses' knowledge	Max score	Pre-Nursing Care Protocol	Immediately Post Nursing Care Protocol	Post 3 Months of Nursing Care Protocol	Paired t test P value (1)	Paired t test P value (2)
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	X ± SD		
• Anatomy and physiology of brain	9	4.32 ± 1.62	8.00 ± 1.16	7.52 ± 1.16	-12.543 <0.001**	-10.777 <0.001**
• Types of brain surgeries	10	5.98±1.87	8.80±1.71	8.44±1.77	-7.885 <0.001**	-6.802 <0.001**
• Indications and contraindications of brain surgeries	10	6.08 ± 2.15	8.84 ± 1.46	8.34 ± 1.67	-7.899 <0.001**	-6.161 <0.001**
• Complications and risks associated with brain surgeries	5	3.08 ± 1.08	4.26 ± 0.80	4.06± 1.01	-5.919 <0.001**	-4.647 <0.001**
Post Operative Nursing Care						
1- Physiological and hemodynamic monitoring	9	4.28 ± 1.60	7.96 ± 1.32	7.64± 1.45	-12.848 <0.001**	-10.791 <0.001**
2- Increased intracranial pressure (Signs & management)	4	1.50 ± 0.83	5.42 ± 0.87	3.24 ± 7.96	-12.804 <0.001**	-11.548 <0.001**
3- Seizures management	3	1.34 ± 0.39	2.54 ± 0.54	2.32 ± 0.68	-8.683 <0.001**	-5.602 <0.001**
3- Pain management	4	1.67 ± 0.87	3.30 ± 0.81	3.16 ± 0.85	-9.806 <0.001**	-7.846 <0.001**
4-Drugs administered as (antibiotics, steroids, opioids, antiseizure, diuretics, GI drugs, anticoagulants)	4	**1.66** ± 1.02	3.12 ± 0.87	2.94± 0.99	-8.058 <0.001**	-6.675 <0.001**
5- wound assessment for bleeding or infection)	6	3.60 ± 1.21	5.20 ± 0.94	4.98 ± 1.03	-8.000 <0.001**	-6.705 <0.001**
6- CSF leakage (signs & management)	4	2.16±0.81	3.50±0.64	3.14±1.81	-9.092 <0.001**	-5.390 <0.001**
7- Nutrition	2	0.74±0.72	1.72±0.45	1.60±0.57	-7.769 <0.001**	-6.416 <0.001**
8- DVT prevention	2	1.16±0.58	1.72±0.45	1.56±0.57	-5.867 <0.001**	-3.395 <0.001**
9- Physical and emotional support	4	1.22±0.88	3.30±0.70	3.10±0.88	-12.515 <0.001**	-10.322 <0.001**
Total knowledge mean score	**76**	**38.88±8.86**	**65.78±8.96**	**62.04±8.77**	**-15.026 0.000****	**13.003 0.000****

(**) Highly statistically significant at ≤0.001

(1) Difference between pre and immediately post nursing care protocol

(2) Difference between pre and post 3 months period of nursing care protocol

Figure (1): Difference Between Nurses' Total Knowledge Level About Brain Surgery and Post Operative Nursing Care Throughout Phases of Study (n=50).



(*) Significant at p ≤0.05
(1) Difference between total knowledge pre and immediately post nursing care protocol
(2) Difference between total knowledge pre and 3months post nursing care protocol

Table (3): Difference Between Total Mean of Nurses' Practices Regarding Post Operative Nursing Care of Patients with Brain Surgery (n=50).

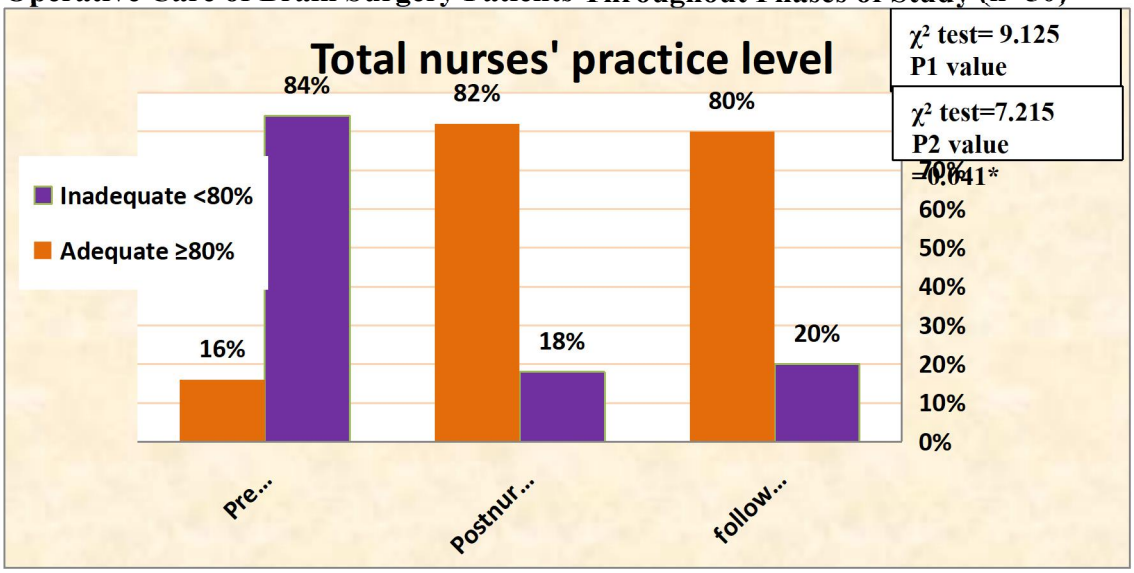
Nurses' practice	Max score	Pre nursing care protocol	Immediately post nursing care protocol	post 3 months of nursing care protocol	Paired t test P value (1)	Paired t test P value (2)
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	X ± SD		
1-Immediate care as:						
• ABC assessment	10	3.54±2.92	9.16±11.63	9.04±1.64	-13.26 <0.001**	-12.714 <0.001**
• Correct Positioning	3	2.52 ±0 .73	2.52 ± 0.88	2.44 ± 0.86	0.127 0.90	0.590 0.558
• Connecting pulse oximeter	6	2.74 ± 1.80	4.42 ± 1.73	4.28± 1.027	-6.597 <0.001**	-6.433 <0.001**
• Connecting Cardiac Monitor	8	2.72 ± 2.92	5.72 ± 2.09	5.52± 2.03	-6.378 <0.001**	-5.912 <0.001**
• Neurological monitoring	16	7.58 ± 3.92	10.70 ± 5.38	10.56 ± 5.26	-3.950 0.001**	-3.33 0.002*
Total	**43**	**19.12 ± 8.18**	**32.52 8.35**	**31.86 ± 7.97**	**-9.79 <0.001****	**-9.409 <0.001****
3-Hemodynamic Monitoring includes:						
• Vital signs	26	23.22 ± 3.39	24.32 ± 2.46	24.20 ± 2.43	-3.845 <0.001**	-3.23 0.002*
• CVP measurement	10	8.94 ± 1.85	8.94 ± 2.13	8.88± 2.10	0.000 1.00	0.312 0.757
• ABG s sample (acid – base	16	7.32 ± 4.59	13.42 ±	13.26 ± 2.93	-7.152	-6.917

Nurses' practice	Max score	Pre nursing care protocol	Immediately post nursing care protocol	post 3 months of nursing care protocol	Paired t test P value (1)	Paired t test P value (2)
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	X ± SD		
balance)			2.98		<0.001**	<0.001**
• Blood Glucose level	4	1.98±0.93	3.40±1.06	3.40±1.06	-7.022 <0.001**	-7.022 <0.001**
Total	**56**	**41.46 ± 7.35**	**50.08 ± 4.98**	**49.74 ± 4.74**	**-8.624 <0.001****	**-8.167 <0.001****
4-Nasogastric feeding	11	5.66±2.88	9.38±1068	9.20±1.57	-7.865 <0.001**	-7.510 <0.001**
5- Fluid and electrolytes balance	5	2.38±1.55	4.18±1.33	4.06±1.30	-7.086 <0.001**	-6.909 <0.001**
6-Pain management	4	2.42±1.45	3.42±1.08	3.26±1.12	-3.913 <0.001**	-3.21 0.002*
7- Warning signs monitoring and management as:						
• Increased ICP	4	1.70±1.35	3.26±1.08	3.14±1.08	-6.713 <0.001**	-6.342 <0.001**
• Seizures	7	3.40±1.51	6.00±1.86	5.86±1.81	-7.832 <0.001**	-7.820 <0.001**
• C.S.F leakage	3	1.16±0.86	2.6±0.78	2.46±0.81	-9.333 <0.001**	-8.139 <0.001**
• Wound infection or bleeding	8	4.02±2.70	7.44±0.90	7.20±0.98	-8.219 <0.001**	-8.060 <0.001**
Total	**22**	**10.30±3.72**	**19.30±4.44**	**18.66±4.31**	-11.880 <0.001**	-12.11 <0.001**
8-Infection control measures						
Hand washing	7	5.34±1.37	6.00±1.17	5.86±1.17	-6.043 <0.001**	-4.383 <0.001**
Wearing PPE	8	5.67±1.76	6.18±1.62	6.00±1.61	-1.500 0.140	-.825 .413
Wound and drain care	9	3.20±1.87	7.58±3.33	7.26±3.18	-7.566 <0.001**	-7.276 <0.001**
Central line Care	5	1.92±1.27	4.18±1.33	3.82±1.32	-8.967 <0.001**	-7.666 <0.001**
Urinary catheter care	5	1.92±1.27	3.92±1.30	3.82±1.15	-8.250 <0.001**	-7.934 <0.001**
Total	**34**	**18.14±5.12**	**27.84±7.21**	**26.74±6.77**	-8.592 <0.001**	-7.988 <0.001**
9- DVT prophylaxis	7	3.70±1.99	6.14±1.55	5.96±1.38	-6.83 <0.001**	-6.890 <0.001**

Nurses' practice	Max score	Pre nursing care protocol	Immediately post nursing care protocol	post 3 months of nursing care protocol	Paired t test P value (1)	Paired t test P value (2)
		$\bar{X}$ ± SD	$\bar{X}$ ± SD	X ± SD		
10-Discharge instructions:						
• Activity restrictions	4	1.74±1.27	3.40±0.80	3.200±7.55	-7.119 <0.001**	-5.159 <0.001**
• Medications	3	1.44±1.01	2.54±0.61	2.32±0.58	-5.994 <0.001**	-6.083 <0.001**
• Diet & hydration	2	0.86±0.96	1.74±0.52	1.74±0.52	-6.083 <0.001**	-6.675 <0.001**
• Seek immediate medical help in case of warning signs (fever, neurological problems, seizures, bleeding, Homan's sign)	6	2.92±2.00	5.22±1.34	5.02±1.09	-6.524 <0.001**	-5.061 <0.001**
• Follow up	2	0.98±0.65	1.74±0.52	1.56±0.57	-6.174 <0.001**	-5.061 <0.001**
Total	17	7.88±3.84	14.64±3.46	13.84±2.88	-8.404 0.001**	-8.617 <0.001**
Total Practice mean score	**217**	**120.28±21.46**	**182.60±29.33**	**178.16±26.48**	-13.342 0.000**	-13.499 0.000**

(**) Highly statistically significant at ≤0.001
(1) Difference between pre and immediately post nursing care protocol
(2) Difference between pre and post 3 months period of nursing care protocol

Figure (2): Difference Between Nurses' Total Practice Level Regarding Post Operative Care of Brain Surgery Patients Throughout Phases of Study (n=50)



(*) Significant at p ≤0.05
(1) Difference between total practice pre and immediately post nursing care protocol
(2) Difference between total practice pre and 3-month post nursing care protocol

Table (4): Correlation Between Total Knowledge and Practice among Studied Nurses Pre and Post Periods of Nursing Care Protocol (n=50).

r-\ p values / *variable*	*Periods*	*Total knowledge*	
		r	**p- value**
Total practice	Pre	0.111	0.44 $^{n.s}$
	Immediately post	0.496	<0.001**
	Post 3 months	0.328	<0.001**

$^{(n.s)}$ Not statistically significant at p> 0.05 (**) Highly statistically significant at ≤0.001

Table (5): Comparison between pre and post nursing care protocol group of studied patients regarding their personal data (n= 66)

Personal data	**Pre nursing care protocol group n= 33**		**Post nursing care protocol group n= 33**		**χ^2**	**P value**
	No	***%***	***No***	***%***		
Age:						
▪ 20-<30	8	24.2	5	15.3	1.01	0.799 n.s
▪ 30-<40	6	18.2	8	24.2		
▪ 40-<50	15	**45.5**	16	**48.5**		
▪ 50-60	4	12.1	4	12		
Mean ±SD	**39.81±9.33**		**40.51±8.22**		**t=0.322**	**p=0.749**
Gender:						
▪ Male	25	75.8	22	66.7	0.97	0.230 ns
▪ Female	8	24.2	11	33.3		
Educational level						
▪ Not read or write	3	9.1	2	6.1	2.23	0.52 ns
▪ Read and write	5	15.2	10	30.3		
▪ Intermediate education	16	48.5	13	39.4		
▪ Higher education	9	27.2	8	24.2		
Occupation						
▪ Office work	6	18.2	6	18.2	1.34	0.71 ns
▪ Manual work	18	54.5	17	51.5		
▪ Housewife	4	12.1	7	21.2		
▪ Not work	5	15.2	3	9.1		
Residence						
▪ Rural	21	63.6	20	60.6	0.64	0.50 ns
▪ Urban	12	36.4	13	39.4		

χ^2= chi square test n.s = no statistical significance

Table (6): Comparison between pre and post nursing care protocol group of studied patients regarding their medical data (n=66)

Patients' medical data	Pre nursing care protocol group n= 33		Post nursing care protocol group n= 33		χ^2	P value
	No	%	No	%		
Diagnosis						
▪ Brain tumor	7	21.2	4	12	2.59	0.763 n.s
▪ Left parietal cystic lesion	5	15.2	7	21.2		
▪ Sub-dural hematoma	12	**36.4**	16	**48.5**		
▪ Obstructed hydrocephalus	4	12	2	6.1		
▪ Aneurysm	2	6.1	2	6.1		
▪ Epileptic seizures	3	9.1	2	6.1		
Previous neurological surgery						
▪ Yes	13	39.4	10	30.3	0.60	0.432 n.s
▪ No	20	**60.6**	23	**69.7**		
Previous Neurological complain ≠						
▪ Headache	24	**72.7**	**22**	**66.7**	**0.28**	0.592 n.s
▪ Change in consciousness	20	60.6	19	57.7	0.63	0.802 n.s
▪ Visual disturbance	16	48.5	11	33.3	1.56	0.210 n.s
▪ Dizziness	**23**	**69.7**	19	**57.7**	**1.04**	0.306 n.s
▪ Seizures	9	27.3	7	21.2	0.33	0.566 n.s
Type of surgery						
▪ Craniotomy	21	**63.6**	20	**60.6**	**1.55**	**0.670** n.s
▪ Craniectomy	7	21.2	10	30.3		
▪ Burr hole	3	9.1	1	3.0		
▪ Biopsy	2	6.1	2	6.1		
Comorbidity						
▪ Diabetes mellitus	6	18.2	9	27.3	1.79	0.616 n.s
▪ Hypertension	18	**54.5**	19	**57.6**		
▪ Renal disease	5	15.2	3	9.1		
▪ Cardiac disease	4	12.1	2	6.1		

≠ More than one response χ^2= chi square test n.s = no statistical significance

Table (7): Comparison between pre and post nursing care protocol group of studied patients according to their clinical risk score immediately post operative and at discharge (n =66).

Clinical risk based on Physiological parameters	Pre nursing care protocolgroup n= 33				Post nursing care protocol group n= 33				χ^2 1 (P 1)	χ^2 2 (P 2)
	Immediately post operative		At discharge		Immediately post operative		At discharge			
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*		
Low risk	2	6.1	9	27.3	8	24.2	19	**57.5**	**6.50 0.03***	**6.23 0.04***
Moderate risk	19	51.6	20	**60.6**	20	**60.6**	12	36.4		
High risk	12	**36.3**	4	12.1	5	15.2	2	6.1		

X^2: Chi-square p= p-value

χ^2 1(P 1) between Pre and post nursing care protocol groups immediately post operative

χ^2 2(P 2) between Pre and post nursing care protocol groups at discharge

Table (8): Comparison between pre and post nursing care protocol group of patients according to their neurological status stability immediately post operative and at discharge (n=66)

Neurological status	Pre nursing care protocol group n= 33				Post nursing care protocol group n= 33				χ2 1 (P 1)	χ2 2 (P 2)
	Immediately post operative		At discharge		Immediately post operative		At discharge			
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*		
▪ **More stable neurological status**	5	15.2	15	**45.5**	12	36.4	26	**78.8**	**6.55 0.034***	**8.86 0.003***
▪ **Impaired neurological status**	12	36.4	15	45.5	14	**42.2**	7	21.2		
▪ **Worse neurological status**	16	**48.4**	3	9.0	7	21.2	0	0.0		

X^2: Chi-square p= p-value

χ^2 1(P 1) between Pre and post nursing care protocol groups immediately post operative

χ^2 2(P 2) between Pre and post nursing care protocol groups at discharge

Table (9): Comparison between pre and post nursing care protocol group of patients according to their headache intensity and characteristics immediately post operative and at discharge (n=66).

Headache	Pre nursing care protocol group n= 33				Post nursing care protocol group n= 33				χ^2 1 (P 1)	χ^2 2 (P 2)
	Immediately post operative		*At discharge*		*Immediately post operative*		*At discharge*			
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*		
Headache intensity									4.730 **0.03***	**22.36 0.000****
▪ Mild	2	6.1	2	6.1	7	21.2	19	**57.6**		
▪ Moderate	11	33.3	23	**69.7**	10	30.3	7	21.2		
▪ Severe	20	**60.6**	8	24.2	16	**48.5**	7	21.2		
Type										
▪ Acute	16	48.5	14	42.4	9	27.3	25	**75.8**	3.15 0.07	7.58 **0.006***
▪ Chronic	17	**51.5**	19	**57.6**	**24**	**72.7**	8	24.2		
Headache relieved by										
▪ Pharmacological	28	84.8	20	60.6	22	66.7	10	30.3	2.97 0.08	6.11 **0.01***
▪ Non pharmacological	5	15.2	13	39.4	11	33.3	23	69.7		

X^2: Chi-square p= p-value

χ^2 1(P 1) between Pre and post nursing care protocol groups immediately post operative

χ^2 2(P 2) between Pre and post nursing care protocol groups at discharge

Figure (3): Comparison between pre nursing care protocol group and post nursing care protocol group of patients regrading postoperative complications immediately post-operative (n=66)

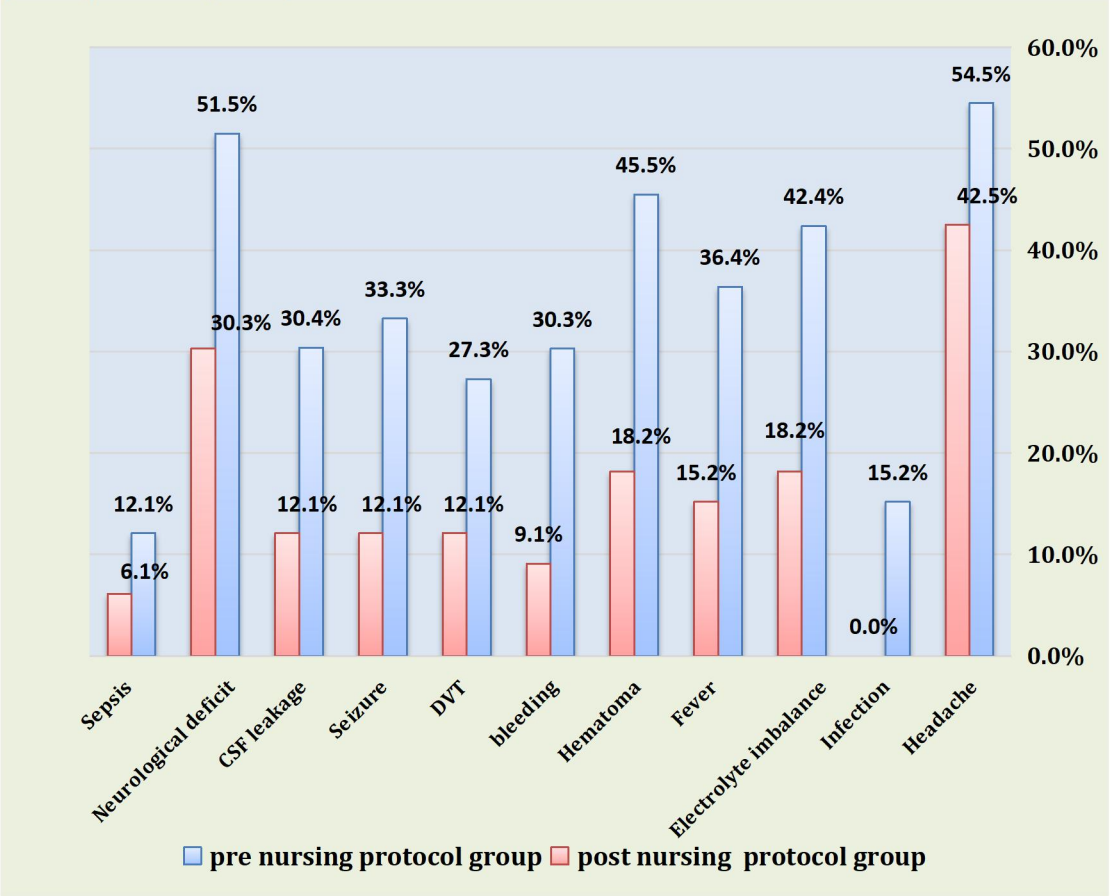


Figure (4): Comparison between pre nursing care protocol group and post nursing care protocol group of patients regrading postoperative complications (n=66)

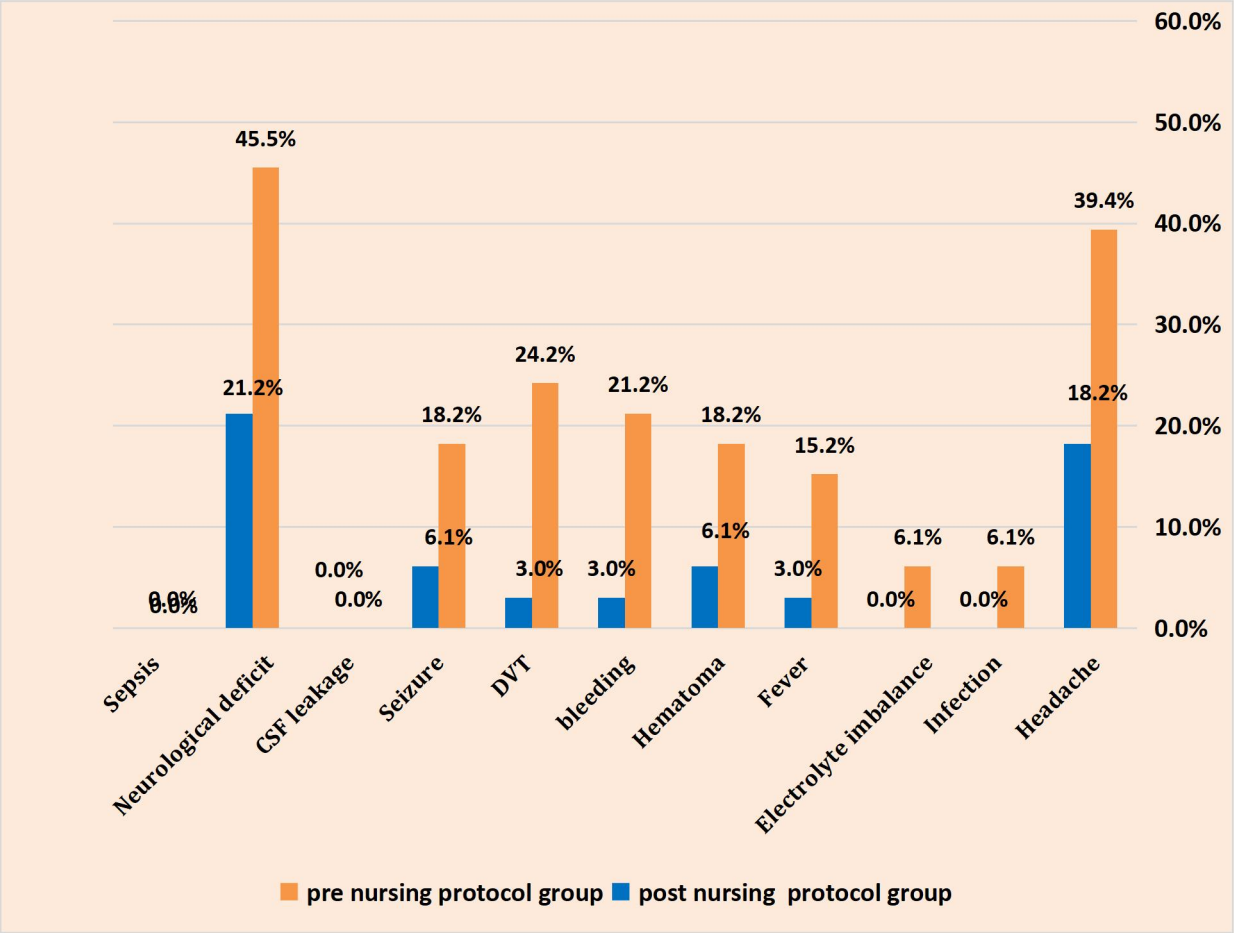


Table (10): Comparison between pre and post nursing care protocol group of patients regarding complications severity immediately post operative and at discharge (n=66)

Landrie II bañez classification	Pre nursing care protocol group n= 33				Post nursing care protocol group n= 33				χ^2 1 (P 1)	χ^2 2 (P 2)
	Immediately post operative		At discharge		Immediately post operative		At discharge			
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*		
▪ **Grade I** (Mild complication)	5	15.1	13	**39.4**	15	**45.5**	25	**75.8**	7.47 **0.02***	10.45 **0.005***
▪ **Grade II :** (Moderate complication)	18	**54.5**	16	48.5	13	39.4	8	24.2		
▪ **Grade III** (Severe complication)	10	30.3	4	12.1	5	15.1	0	0.0		

(*) Significant at p ≤0.05

Discussion

Brain surgery plays a critical role in the diagnosis and treatment of various neurological conditions, including brain tumors, traumatic injuries, epilepsy, and congenital abnormalities. It is essential for relieving pressure on the brain and improving neurological function. Advances in surgical techniques, such as minimally invasive and image-guided procedures and nursing management have significantly increased the success rate and

reduced complications and improve patients' quality of life and, in many cases, is a life-saving intervention that restores function and prevents further deterioration **(Kalkan et al., 2022)**

Concerning the personal data of studied nurses, the findings of the current study clarified that more than half of the nurses were aged between 20 to less than 30 years, with a mean age of 28.60 ± 6.30 years. This reflects a relatively young nursing workforce, and recent educational exposure, however also have limited clinical experience. This finding consisted with **Ali et al., (2021)** in a study entitled "Assessment of critical care nurses' knowledge and performance regarding care of patients with increased intracranial pressure" in Egypt reported similar age distributions indicating a trend of early career nurses populating critical care and surgical units. However, **Walker et al., (2023)** in a study entitled "Retention and performance of neurosurgical nurses in Canadian tertiary hospitals" in Canada noted that most neurosurgical nurses in their samples were in the 30–45 age range

Regarding gender, three quarters of the studied nurses were female. This aligns with global trends, where the nursing profession remains largely female-dominated, as reported by the **World Health Organization (2023)**. Similarly, **Hassan and Ibrahim (2022)** in a study entitled "Training gaps and professional readiness among neurological ICU nurses" in Egypt found that the majority of neurology nurses in Egypt were female, reinforcing the gender distribution pattern.

As for academic qualifications, half of the nurses had technical nursing institutes this indicates that half of the neurosurgical nursing staff may have limited academic preparation, particularly in areas requiring advanced clinical decision-making, critical thinking, and specialized knowledge. This result is comparable to **El-Sayed and Abdel-Aziz, (2022)** in a study entitled "Nurses' knowledge and practices toward neurosurgical patients in intensive care units" in Egypt which showed that approximately half of nurses in surgical departments had technical nursing institutes qualifications. The high percentage of this qualification holder raises concerns about preparedness. While **Zhang et al., (2023)** in a study entitled "Educational attainment and clinical competence among neurological nurses" in China found that more than half of neurology nurses held bachelor's degrees.

In relation to years of experience, one third of the nurses had 1 to <5 years of experience in the neurosurgery department, with a mean experience of 6.22 ± 3.55 years. This suggests a moderately experienced nursing workforce, though a notable portion remains in the early stages of neurosurgical practice. Similar **Patel et al., (2022)** in a study entitled "Clinical decision-making and experience levels among neurology nurses" in India by found that more than one third of nurses in neurology units had fewer than five years of experience. In contrast **Salem and Khalaf (2023)** in a study entitled "Evaluation of nurses' clinical experience and competence in neurosurgical intensive care units" in Egypt found that the majority of neurosurgical nurses in their study had over five years of experience.

Regarding attendance of any training course, about two thirds of nurses reported didn't have any training courses related to care of patients with brain surgeries. This is a significant finding, as it suggests a gap in professional development in a highly specialized and critical field. This result is consistent with **Mohamed and Selim, (2023)** in a study entitled "Nurses' training needs in neurosurgical and trauma ICUs: A cross-sectional study" in Egypt which showed that more than three fifth of neurosurgical ICU nurses had not received formal training related to neurosurgical patient care.

Related to studied nurses' knowledge score, the study revealed that only tenth of the studied nurses had satisfactory level of knowledge regarding brain surgeries and nursing management pre nursing care protocol implementation compared to majority of them had satisfactory level of knowledge at immediate and post three months of implementation nursing care protocol. From the researchers' perspective, this could be attributed to the impact of the nursing care protocol, as evidenced by improvements in nurses' knowledge.

This finding consisted with **Shady et al., (2025)** in a study entitled "Enhancing nursing practice through patient outcome measures: a framework for optimizing care in intracranial surgery" in Egypt stated that there was a statistically significant improvement in nurses' knowledge scores from pre- to post-intervention. These results also consisted with **Cheng et al., (2023)** in a study entitled "Enhancing neurosurgical nursing care through protocol-based training" in China observed a marked increase in nurses' neurosurgical knowledge after a simulation-based protocol was introduced, rising from less than fifths to more than three quarters satisfactory scores post-training.

Related to studied nurses' practices, The study revealed that, only less than fifth of the studied nurses had adequate level of practices pre nursing care protocol implementation compared to the majority of them had adequate level of practices at immediate and post 3 months of nursing care protocol implementation with significant statistical difference as p value $p \leq 0.05$. From the researchers' perspective, this could be attributed to the impact of the nursing care protocol, as evidenced by improvements in nurses' practice.

This finding consisted with **El-Mahdy and Soliman, (2023)** in a study entitled "Effect of a clinical guideline on nurses' performance regarding care of post-neurosurgery patients" in Egypt reported that there was a significant improvement in nurses' practices after applying a care protocol for post-operative neurosurgical patients in intensive care units. These results also agreed with **Brown et al., (2023)** in a study entitled "Enhancing neurosurgical nursing practice through protocol-based care: A pre-post interventional study" in the United Kingdom demonstrated that protocol-guided training resulted in reduced errors, and more confident clinical decision-making and practices among neurosurgical nurses.

The current study demonstrated a positive and highly significant **correlation between total nurses' knowledge and their total practice scores** immediately and three months after the implementation of the nursing care protocol. This finding reinforces the widely accepted concept that improved theoretical understanding positively influences clinical performance, especially in complex care settings like neurosurgery. This result was in agreement with **Farag and Amin (2023)** in a study entitled "Impact of a training program on nurses' performance regarding care of patients with brain disorders" in Egypt who reported a statistically significant relationship between nurses' knowledge levels and their practical competencies following an educational intervention in neurological units. These results also agreed with **Lee et al., (2022)** in a study entitled "Impact of clinical simulation training on neurosurgical nurses' knowledge and practical skills: A correlational study**''** in South Korea supported these findings, showing that targeted clinical training improved nurses' practical performance, which was significantly associated with their theoretical understanding

Concerning the personal data of studied patients, the findings of the current study clarified that approximately two fifths of both groups (pre and post nursing care protocol groups) in the age category 40to less than 50 years old with mean 39.81±9.33 and40.51±8.22this indicates that middle-aged adults form a significant portion of the patient population undergoing brain surgery.

These findings are in agreement with **Ali and Ghoneim (2023)** in a study entitled "Demographic characteristics and clinical outcomes among patients undergoing neurosurgical interventions" in Egypt who reported that approximately two fifths of patients undergoing brain surgery were within the 40–50 age groups. On the other hand, a study conducted by **Kassahun et al., (2021)** in a study entitled "Patterns and outcomes of neurosurgical admissions in a tertiary hospital" in Ethiopia found that the more than half of neurosurgical patients were younger, between 20 and 39 years.

Regarding patients' gender, three quarters of pre nursing care protocol groups and two thirds of post nursing care protocol groups were males indicating a slight male predominance among those undergoing brain surgery. This is

consistent with **Ahmed and El-Deeb (2023)** in a study entitled "Evaluation of nursing interventions and outcomes among patients undergoing brain surgery" in Egypt reported that both the control and study groups were males in three quarters of cases admitted for brain surgery. Likewise, **Wu et al., (2021)** in a study entitled "Gender patterns in patients undergoing neurosurgical procedures" in East Asia found a more balanced gender distribution accounted for nearly half of the brain tumor surgery cases from both sex.

As regard to patients' occupation, more than half of both groups had manual work indicating that individuals in physically demanding occupations are more frequently affected by conditions requiring brain surgery. This result aligns with **Ali et al., (2022)** in a study entitled "Occupational risks and patterns of neurosurgical admissions in a tertiary hospital" in Egypt who reported that more than half of neurosurgical patients were manual workers. Conversely, a study by **Martínez-Rodríguez et al., (2021)** in a study entitled "Socioeconomic and occupational profile of patients undergoing brain surgery" in Spain revealed a more balanced occupational distribution in studied patients

In relation to patients' medical data, more than one third of pre nursing care protocol groups and more than two fifths of post nursing care protocol groups were diagnosed with subdural hematoma (SDH), making it the most frequent clinical diagnosis among neurosurgical admissions. This suggests a high prevalence of trauma-related brain injuries. This finding is in agreement with **El-Sayed and Khalil (2023)** in a study entitled "Patterns and outcomes of emergency neurosurgical admissions" in Egypt found SDH to be one of the leading causes of emergency neurosurgical intervention. However, **Garcia et al. (2023)** in a study entitled "Age and clinical profile of patients in Brazilian neurosurgical intensive care units" in Brazil found that brain tumors were the most common diagnosis among their neurosurgical population, followed by aneurysms and hydrocephalus.

More than two thirds of both groups reported headache, as previous neurological complaints. These symptoms are consistent with typical presentations of various neurosurgical conditions such as subdural hematoma, brain tumors, or cerebrovascular disorders, this finding is supported by **El-Mahdy and Soliman (2022)** in a study entitled "Preoperative neurological symptoms among patients undergoing brain surgery" in Egypt who found that more than two thirds of patients undergoing neurosurgery presented with persistent headache, often associated with increased intracranial pressure.

In relation to type of surgery, more than three fifths of both groups had craniotomy indicating that it was the most common neurosurgical procedure performed. This reflects the broad utility of craniotomy in managing a wide range of neurological conditions, including subdural hematomas, brain tumors, abscesses, and traumatic brain injuries. This finding is supported by **El-Sharkawy et al., (2022)** in a study entitled "Pattern of surgical procedures in neurosurgery departments: A retrospective study" in Egypt found craniotomy to be the most frequent surgical intervention among patients in the neurosurgical department of Mansoura University Hospital. However, **Kim et al., (2023)** in a study entitled "Trends in neurosurgical procedure selection in South Korea" noted that minimally invasive techniques such as endoscopic and stereotactic procedures were increasingly replacing traditional craniotomies.

As regard to patients' comorbid disease, more than half of both groups had hypertension this aligns with the well-documented association between elevated blood pressure and various neurosurgical disorders, such as intracranial hemorrhage, subdural hematoma, aneurysms, and brain tumors, especially in middle-aged and older adults this aligns with **Saleh et al. (2024)** in a study entitled "Blood pressure control and outcomes in hypertensive patients undergoing craniotomy" in Egypt found that more than half of craniotomy patients were hypertensive. In contrast, **Patel et al,. (2024)** in a study entitled "Comorbidity prevalence in neurosurgical

admissions: Insights from a trauma-focused center in India" documented hypertension in only less than two fifths of neurosurgical admissions, largely due to a trauma dominant population skewed toward younger patients without established chronic diseases.

In relation to clinical risk score based on physiological parameter assessment using National Early Warning Score (NEWS)**,** more than one third of the pre-nursing care protocol group had high clinical risk immediately post-operative compared to three fifths of the post-nursing care protocol group who exhibited moderate risk levels. However, by the time of discharge, three fifths of the pre-protocol group had moderate risk while more than half of the post-protocol group showed low risk. This shift suggests a positive impact of early postoperative monitoring and timely nursing interventions in promoting patient stability following brain surgery.

These results are supported by **Hassan and Fathy, (2024)** in a study entitled "The impact of early warning score monitoring on clinical deterioration in postoperative neurosurgical patients" in Egypt which observed a reduction in NEWS scores among neurosurgical patients after structured postoperative nursing care, with moderate-risk patients decreasing from three fifths to two fifths within four weeks. In contrast, **Lee et al. (2023)** in a study entitled "Early physiological deterioration after brain surgery: The role of standardized monitoring" in South Korea reported slower recovery trends in hospitals without routine early warning monitoring, suggesting that structured postoperative surveillance plays a key role in early detection of deterioration and improved patient trajectories.

Regarding neurological status assessment, more than one third of the pre-nursing care protocol group had a high clinical risk immediately post-operatively, while three fifths of the post-nursing care protocol group had a moderate clinical risk at the same time point. By the time of discharge, three fifths of the pre-protocol group showed moderate risk, whereas more than half of the post-protocol group had transitioned to low clinical risk. This progressive improvement highlights the effectiveness of postoperative neurosurgical management and structured nursing assessments in promoting neurological recovery.

These findings align with **Shalaby et al., (2024)** in a study entitled "Neurological outcome in postoperative brain surgery patients: The effect of structured nursing assessment" in Egypt reported a marked improvement in Glasgow Coma Scale and neurological function scores among neurosurgical studied patients over a 4-week period post-surgery, especially when nurse-led neurological assessment protocols were applied consistently. In contrast, **Singh et al. (2023)** in a study entitled "Trends in neurological recovery post brain surgery: Role of follow-up care in resource-limited settings" in India reported slower neurological recovery among patients lacking structured post-operative rehabilitation and follow-up, with only three fifths reaching functional neurological stability by day thirty.

As regards to headache intensity as indicator of complications, three fifths and more than half of pre nursing protocol group had severe headache and chronic type immediately post-operative compared to less than half and more than two thirds of post nursing protocol group respectively. While at discharge more than two thirds of pre nursing protocol group had more moderate headache, whereas more than half of post nursing protocol group had mild headache. This shift was statistically significant and indicates an overall reduction in headache severity over time.

Similarly, **Rodriguez et al., (2023)** in a study entitled "Postoperative headache management after brain surgery: A multimodal approach" in Spain found that postoperative headaches occurred in more than half of brain surgery patients, but those who received comprehensive pain education and multi-modal pain relief plans had faster reduction in headache severity. In contrast, **Chang et al., (2024)** in a study entitled "Chronic postoperative headache after craniotomy: A challenge in neurorehabilitation" in Taiwan noted that persistent chronic headaches lasting

beyond four weeks were associated with limited pain management education and underuse of non-drug interventions.

Regarding brain surgery complications, more than half, two fifths & half of pre nursing protocol group had headache, hematoma and neurological deficit respectively immediate post-operative compared to two fifths, less than fifths & less than one third respectively of post nursing protocol group. While at discharge less than two fifths and two fifths of pre nursing protocol group had headache and neurological deficit respectively compared to less than fifth and one fifth respectively of post nursing protocol group. This noticeable reduction suggests the effectiveness of postoperative monitoring, early interventions and the critical role of nursing care in preventing and managing neurosurgical complications.

These findings are consistent with those of **Sami and El- Masry (2023)** in a study entitled "Common early postoperative complications among patients undergoing brain surgery and nursing strategies for prevention**"** in Egypt, who reported that more than two thirds of patients experienced moderate-to-severe headaches and two fifths had bleeding within the first 48 hours post-craniotomy, but these complications subsided considerably by the end of the first month due to continuous assessment protocols and timely medical intervention.

In contrast, **Kim and Park (2024)** in a study entitled "Long-term complications following brain surgery: A national cohort study in South Korea" found a slower rate of complication reduction among patients lacking access to specialized neuro-rehabilitation, with persistent neurological deficits in less than third of cases after one month.

Finally, concerning complications severity using Landrie lI bañez classification; more than half of pre nursing protocol group had moderate complication while approximately two fifths of post nursing protocol group had mild complication immediate post-operative while at discharge; slightly less than two fifths of pre nursing protocol group had mild complication compared to three quarters of post nursing protocol group. This notable improvement suggests the effectiveness of structured postoperative care, early complication detection, and targeted nursing interventions in promoting recovery among neurosurgical patients.

Similarly, **Abd El-Monem et al., (2024)** in a study entitled "Monitoring complication severity in postoperative neurosurgical patients: A nursing perspective" in Egypt found that half of their patients had moderate complications immediately post-operative, which dropped significantly over time with nursing-led interventions. However, contrasting findings by **Nguyen et al., (2024)** in a study entitled "Postoperative recovery trends among neurosurgical patients: Influence of nursing follow-up in low-resource settings" in Vietnam showed a slower decline in complication severity, particularly in facilities with limited post-discharge follow-up, underscoring the importance of long-term nursing surveillance and continuity of care.

Conclusion

Based on the findings of the present study, it can be concluded that post-operative nursing care protocol effectively improved nurses' knowledge, practices, and health outcomes among brain surgery patients.

Recommendations

Based on the findings of the study, the following recommendations are suggested

- Adoption and integration evidence-based nursing care protocols into routine clinical practice in neurosurgical units.
- ongoing nursing educational programs is necessary to update knowledge and practice.
- Conducting ongoing educational programs for nurses regarding rehabilitation and functional recovery of brain surgery patients is necessary.
- Using standardized tools and neurological checklists to guide periodic assessment and monitoring patient condition postoperatively and enhance appropriate nursing interventions

Recommendations for further research

- Explore the relationship between improved nursing practices and long-term patient outcomes such as quality of life, readmission rates, and rehabilitation progress post brain surgery.
- Investigate the organizational, educational and individual barriers that hinder the adoption of nursing care protocols in neurosurgical units.

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