

Effect of Educational Program about Care of Stroke Patients who Administrated Tissue Plasminogen Activator on Nurses' Performance and Health Outcomes

Safaa Mohamed Hamed ¹, Noura Fares Mohamed²&Rasha Fathy Mohamed³

[1,3] Assistant Professor of Medical Surgical Nursing -Faculty of Nursing - Benha University, Egypt

[2] Lecturer of Medical -Surgical Nursing- Faculty of Nursing- Benha University, Egypt

Abstract

Context: The use of tissue plasminogen activator (tPA) as a thrombolytic agent in ischemic stroke necessitates vigilant nursing care, ensuring swift interventions to control potential risks and complications and promote favorable patient outcomes. **Aim:** was to investigate the effect of educational program regarding care of stroke patients who administrated (tPA) on nurses' performance and health outcomes. **Research design:** The study employs a quasi-experimental (pre–post) design. It was conducted in the stroke care unit of Benha University Hospital, Qualubia, Egypt. The study included a convenience sample of 50 nurses and a purposive sample of 80 ischemic stroke patients eligible for tPA therapy, who were assigned equally to a study and a control group. Data were collected using three instruments: (I) a structured interview questionnaire for nurses, (II) Nurses' observational checklist to evaluate nursing practices, and (III) a patient health outcomes assessment record. **Results:** Nurses' overall knowledge and practice levels increased markedly post educational program. Immediately post-intervention, 88% of nurses demonstrated satisfactory knowledge compared with only 20% before the program. Likewise, 84% achieved adequate practice levels after the training, up from 34% pre-program, with statistically significant differences. In addition, patients in the study group showed significant improvement in health outcomes, reflected in reduced clinical risks and lower stroke severity scores during the tPA administration period. **Conclusion:** The educational program produced a statistically significant improvement in nurses' knowledge and clinical performance. In addition, ischemic stroke patients who received care from the trained nurses showed reductions in both clinical risk scores and stroke severity levels. **Recommendations:** Arabic-language resources should be made available to nurses in their workplace, including simplified and comprehensive educational guidelines, posters, and booklets outlining nursing responsibilities before, during, and after tPA administration.

Keywords: Health outcomes, Nurses' performance, Stroke, Tissue plasminogen activator.

Introduction

Stroke continues to be a major global contributor to mortality and is the foremost contributor to long-term disability. Over the past decade, diagnostic capabilities and therapeutic interventions for acute ischemic stroke have advanced substantially. A critical component of stroke management is the early recognition of symptoms and rapid transfer of patients to facilities capable of delivering timely, specialized treatment. The primary objective in treating acute ischemic stroke is to restore blood flow to the affected brain tissue as quickly as possible (**Maalouf et al., 2023**).

Intravenous thrombolysis with tissue plasminogen activator (tPA) is most effective when administered within 4–5 hours of symptom onset. During a stroke event, approximately two million neurons are lost every minute, reinforcing the urgency of the phrase “Time is Brain.” Quality improvement initiatives—such as prehospital alerts, activation of an acute stroke protocol, accelerated triage, and direct transport to radiology—have significantly improved early delivery of thrombolytic therapy. Evaluating how well these interventions enhance timely treatment remains essential (**Hughes et al., 2020**).

tPA is considered the first-line pharmacological therapy for acute ischemic stroke and has demonstrated effectiveness in improving long-term outcomes. It is also cost-effective in reducing disability and mortality. The drug functions within the body’s fibrinolytic system by converting plasminogen into plasmin through hydrolysis of the arginine–valine bond. Activated plasmin subsequently breaks down fibrin and fibrinogen, enabling

clot dissolution and restoration of cerebral blood flow. Candidates for tPA therapy are those who show acute ischemic stroke symptoms, present measurable neurological deficits, have no evidence of bleeding or stroke mimics on initial CT imaging, and arrive within the 4–5-hour therapeutic window (**Babkair et al., 2023**).

Although tPA offers substantial benefits in improving outcomes for patients with acute ischemic stroke, it is also associated with significant risks. Intracerebral hemorrhage represents the most severe complication, while additional adverse effects may include extracranial bleeding, orolingual angioedema, and seizures. The need for rapid recognition and management of these complications underscores the critical importance of vigilant nursing care during tPA administration (**Lema et al., 2024**).

Nurses are required to closely observe patients for indications of major or minor bleeding, neurological decline, or signs of orolingual angioedema—such as abrupt severe headache, marked hypertension, nausea, vomiting, or worsening neurological status. If any of these manifestations are detected, tPA infusion must be discontinued immediately, followed by urgent CT imaging (**Shah et al., 2022**).

Symptomatic intracranial hemorrhage (SICH), the most severe complication of tPA, occurs in approximately 6.4% of cases in the research conducted by the National Institute of Neurological Disorders and Stroke (NINDS) and up to 8.8% in the ECASS II study. Among patients who develop SICH after thrombolysis, the in-hospital mortality rate was 52.3%. Orolingual angioedema is another potentially life-threatening side effect,

occurring in 1–5% of patients, with as many as 65% of cases associated with concurrent use of ACE inhibitors (El Labban et al., 2024).

Nurses hold a pivotal role in identifying stroke symptoms, triaging patients, and initiating tPA therapy. They must be knowledgeable about the correct dosage and specific administration protocol for stroke, which differs from that used in myocardial infarction. Thrombolytic treatment for stroke requires intensive neurological monitoring to quickly detect complications. Intracerebral hemorrhage often presents with abrupt neurological decline and unstable vital signs. Therefore, continuous assessment of vital signs, neurological status, cardiac rhythm, and patients' critical parameters is essential to achieving the best possible outcomes (Miao et al., 2023).

Significance of the study.

Stroke is recognized as the second leading cause of death worldwide and a major source of long-term disability among adults. In Egypt, it ranks as the third most common cause of mortality, following heart and liver disease. In Upper Egypt alone, more than 250,000 new stroke cases are reported each year, with at least 75% of affected individuals experiencing substantial residual disability. Nationally, the rate of thrombolysis remains low at 4.5%, and only 52% of healthcare institutions provide thrombolytic therapy—approximately half of these are university hospitals, while about 10% fall under the Ministry of Health (Khattab et al., 2019). At Benha University Hospital, roughly 195 patients received tPA treatment in 2024 (Benha University Hospital Statistical Office, 2024).

Nurses had a critical role in the safe administration of tPA. Nurses can

minimize the potential risks and complications associated with its use. Stroke nurses are responsible for closely monitoring patients' neurological status and vital signs before, throughout, and after the infusion. They must also be well informed about the inclusion and exclusion criteria for tPA eligibility, be able to recognize adverse reactions, and know when to discontinue the medication immediately—such as in cases of allergic response or uncontrolled bleeding.

Aim of the study

The study aims to investigate the effect of educational program about care of stroke patients who administrated tissue plasminogen activator on nurses' performance and health outcomes through:

- Assessing nurses' knowledge and practice levels regarding care of stroke patients who administrated tPA.
- Designing and implementing educational program about care of stroke patients who administrated tissue plasminogen activator (tPA).
- Evaluating the effect of educational program on nurses' performance and patients' health outcomes.

Research hypotheses

- Nurses' mean knowledge scores related to tPA administration for ischemic stroke patients would be higher after the intervention than before it.
- Nurses' mean practice scores concerning tPA administration care would improve significantly following the intervention compared with pre-intervention levels.
- The mean scores of patients' health outcomes would show significant enhancement after the educational program compared to pre-program measurements.

Operational definition

Health outcomes: included patient' clinical risk and stroke severity score (mild, moderate, severe) as lower scores indicate improved patient' health status.

Nurses' performance refers to knowledge, practice

Subjects and method

Research Design

A quasi-experimental research (pre/post-test) design was adopted for this study. This type of design is commonly used to explore associations, describe specific phenomena, or assess cause-effect relationships while offering less experimental control than true experimental designs. Such reduced control may relate to manipulation of the intervention, regulation of the study environment, or selection of participants. In clinical nursing research, convenience sampling is often used rather than random assignment, making quasi-experimental designs more prevalent in this field (Sefidkar & Madadizadeh, 2022).

Study Variables

The independent variable in this study was the structured educational program developed by the researchers. The dependent variables included nurses' performance outcomes, represented by their knowledge and practice scores. Patient outcome variables—specifically clinical risk levels and stroke severity scores—were also examined as dependent measures.

Setting

The research took place in the stroke unit of Benha University Hospital, Qualubia Governorate, Egypt. The unit, located on the seventh floor, consists of 11 beds distributed between two rooms—six beds in the first room and five beds in the second.

Subjects

They were two groups after exclusion of pilot study including:

-**A convenience sample** of 50 stroke care unit nurses who provided direct care to stroke patients and agree to participate in the study.

-**Purposive sample** of 80 ischemic stroke patients who eligible for tissue plasminogen activator administration and distributed into two equal groups as follows:

- The control group (40 patients) received standard nursing care during tPA administration before the educational program was implemented.
- The study group (40 patients) received nursing care during tPA administration after the nurses had completed the educational program sessions.

The sample size for this study was determined using Steven Thompson's formula (Thompson, 2012). The calculation was based on a total population of 195 patients, with a neutral proportion (p) of 0.12, a margin of error (d) of 0.05, and a significance level corresponding to a z-value of 1.96. $n = 89$

Inclusion criteria for patients: adult patients aged 20 to 60 years who diagnosed as ischemic stroke, admitted to hospital within the first hours of attack specifically the first 4-5 hours and not receive any anticoagulant or antiplatelet therapy within 24 hours.

Exclusion criteria: uncontrolled hypertension patients, recent surgery, intra cranial hemorrhage, intracranial neoplasm, arteriovenous malformation, or aneurysm, pregnant women, old age patients with late stages diseases, heparin-based treatment cases as venous thrombosis, and bleeding tendency patients with decreased platelet counts and prolonged PT, PTT, INR time (McGregor, 2024)

Tools of data collection:

Tool (I): structured interview questionnaire for nurses

The study employed a pre/post-test design to evaluate nurses' knowledge about caring for patients receiving intravenous tissue plasminogen activator. It was created by the researcher following an extensive literature review (Shah et al., 2022; Miao et al., 2023; Lema et al., 2024). It consisted of two primary sections:

Part (1): This section collected demographic data about the nurses, (such as their age, gender, educational qualifications, years of experience, and prior training related to intravenous recombinant tissue plasminogen activator).

Part (2): This section focused on evaluating the nurses' knowledge through 25 multiple-choice questions designed to cover all relevant knowledge areas and was divided into three subsections as follows:

- Subsection I: This subsection assessed nurses' knowledge about definition, stroke types, comprising 4 questions.
- Subsection II: This subsection focused on the nurses' understanding of stroke causes and its complications involving 6 questions.
- Subsection III: This subsection evaluated nurses' knowledge regarding tissue plasminogen activator as its action, time of administration, dose, administration criteria and precautions, side effects, and nursing role in the three caring phases. It consists of 15 questions.

Scoring system

Each question was assigned one point for a correct answer and zero for an incorrect response, yielding a maximum total score of 25. The summed scores were then converted to percentage values and classified as follows: a score of 80% or higher (20 points or more) was considered

satisfactory, while a score below 80% (fewer than 20 points) was regarded as unsatisfactory.

Tool (II): Observational Performance Checklist for Nursing Practice

This checklist was created by the researchers following an extensive review of recent and relevant literature and scientific evidence. It was intended to evaluate nurses' practices before, during, and after the administration of intravenous tPA to stroke patients (Li et al., 2023; Lip & Ntaios, 2022; Miao et al., 2023). It consisted of

- **Pre administration care** as vital signs, assessment of stroke symptoms severity, invasive procedures as canulation, insertion of Ryle tube, urinary catheterization, blood sample for recommended lab investigations, glucose level measurement, attachment to pulse oximeter and cardiac monitor (77 steps).
- **During administration care:** included dilution of tPA drug, dose calculation, IV administration 10% bolus and 90% IV infusion (15 steps).
- **Post administration care as** monitoring side effects, when to stop infusion (8 steps).

Scoring system

Each step in the procedure was evaluated as follows: two points were assigned when the step was performed correctly and completely, one point when it was performed correctly but incompletely, and zero points when it was incorrectly done or not performed. The maximum achievable score on the practice checklist was 100 points. Scores were interpreted as follows: performance was considered adequate if the nurse achieved 85% or more (85 points or higher), while scores below 85% (less than 85 points) were classified as inadequate.

Tool III: patient' health outcomes assessment record

It was used to assess clinical risk score throughout monitoring patients' physiological parameters and stroke severity level. This tool employed on two occasions: Once prior to implementing the educational program (for control group) and again after implementation (for study group). It consists of four parts as outlined below:

Part (1): Socio demographic data of patients: This section gathered data about patients' age, gender, marital status, educational background, place of residence, and smoking habit.

Part (2): Medical data related to stroke: This section included 4 questions related to time of hospital admission, risk factors, clinical manifestations, and initiation time of tPA administration.

Part (3): National Institutes of Health Stroke Scale (NIHSS): This section, adopted from **Brott et al. (1989)**, and used by the researcher to evaluate the stroke severity among studied patient consisting of 42 items divided into eleven categories: level of consciousness (three items), LOC questions (two items), LOC commands (three items), best gaze (three items), visual acuity (four items), facial palsy (four items), motor arm (five items), motor leg (five items), limb ataxia (three items), and sensory loss (two items), and best language (three items), dysarthria (three items), extinction or inattention (two items).

Scoring System

The NIHSS employs a 4-point Likert scale for each item, producing a total score ranging from 0 to 42, with higher scores indicating more severe neurological impairment (**Heldner et al., 2013**). Scores are interpreted as follows: 0 indicates no stroke, 1–4 reflects mild stroke, 5–15 denotes moderate stroke, 16–20 represents

severe stroke, and 21–42 indicates very severe stroke.

Part (4) utilized the National Early Warning Score (NEWS), adapted from **Moore and Cunningham (2021)**, to assess clinical risk at baseline, 2 hours, 6 hours, and 12 hours post-administration. The tool evaluates key physiological parameters—including respiratory rate, O₂ saturation, Bp, Heart rate, temperature, and consciousness level—assigning each a score of 0 to 3. Higher scores indicate greater deviation from normal values and increased patient deterioration. Total scores are interpreted as follows: 1–4 indicates low risk, 5–6 reflects medium risk, and a score of 7 or above signifies high clinical risk.

A structured educational booklet was developed for nurses responsible about caring for patients receiving tissue plasminogen activator. The researchers created this booklet after recent literature reviewing (**You et al., 2024; Yan et al., 2025**), with the aim of strengthening nurses' learning according to their identified needs. The booklet was produced in Arabic and featured color illustrations to enhance comprehension. It consisted of two main components:

- The theoretical section, which addressed the stroke definition, its types, causes, risk factors, possible complications, and detailed information on tissue plasminogen activator—including its mechanism of action, dosage, timing of administration, safety precautions, indications for stopping the infusion, potential side effects, and the essential nursing responsibilities.
- The practical section, which focused on the required nursing practices before, during, and after administering tPA to stroke patients.

Ethical and administrative considerations

Ethical and administrative approvals were secured prior to initiating data collection. Approval was first obtained from the Faculty of Nursing Ethics Committee under code REC/MSNP 72, followed by official authorization from the medical director and administrative leadership of the stroke care unit at Benha University Hospital. The study's aim, process, and potential benefits were clearly explained to all participating nurses and patients, who were informed that participation was entirely voluntary and that they could withdraw at any time without penalty. Verbal and written informed consent were obtained from each participant, and all collected information was handled confidentially and used solely for research purposes.

Preparatory Phase

In this initial phase, an extensive review of relevant literature was undertaken to guide the development of the data collection tools. During this stage, both nurses and patients included in the study were assessed, and the phase concluded with the implementation of a pilot study.

Validity of the Tools

The instruments were evaluated for face and content validity by a panel consisting of five medical-surgical nursing experts from the Faculty of Nursing at Benha University and a neurology specialist from the Faculty of Medicine. The panel assessed each tool for relevance, clarity, accuracy, and suitability. Their evaluation indicated agreement on 98% of the items in the structured questionnaire for nurses, 98% of the items in the observational checklist for nursing practice, and 97% of the items in the patient health outcomes assessment form. The educational booklet used in the training program was also reviewed by the same experts. Necessary revisions were incorporated before the

final versions of the tools were used to collect data.

Reliability of the Tool

Reliability was assessed using the test-retest technique, and internal consistency was evaluated through Cronbach's alpha. The instruments demonstrated strong reliability, with coefficients of $r=0.952$ for the interview questionnaire, $r=0.858$ for the performance checklist, and $r=0.93$ for the patient health outcomes assessment record.

Pilot Study

A pilot study involving 10% of the total sample (5 nurses and 9 patients) was conducted to examine the clarity, relevance, and practicality of the study instruments and the nursing care standards booklet. The pilot also assessed the time needed to complete each tool and identified any potential barriers to data collection. Necessary revisions were made based on the pilot results. Because modifications were implemented, pilot participants were excluded from the final study sample. The pilot study was completed two weeks before the commencement of formal data collection.

Data Collection

Data collection process and application of the educational program were conducted over an eight-month period, from December 2024 to July 2025. The researcher attended the clinical setting during the morning shift three days per week on a rotational basis.

The study progressed through four main phases

Phase I: Assessment Phase

During assessment phase, researchers collected demographic information for each participating nurse. Tool I (the structured questionnaire) was then administered to assess nurses' baseline knowledge

regarding the care of stroke patients receiving tPA. Tool II (the performance checklist) was simultaneously used to evaluate nurses' practical skills through direct observation before, during, and after tPA administration. In addition, Tool III (the patient health outcomes assessment) was applied to the control group to measure clinical risk and stroke severity, forming the baseline data set for comparison.

Phase II: Planning Phase

Once the preliminary assessment was completed, an educational program was developed to address the identified learning needs of nurses. The researchers established both general and specific learning objectives and created a structured program plan utilizing a range of instructional strategies, including lectures, group discussions, and brainstorming for theoretical content. Demonstration and return-demonstration were integrated for skill-based training. All necessary teaching aids—such as printed materials, PowerPoint slides, instructional videos, and an appropriate training venue—were arranged. A clear schedule for the training sessions was also organized in coordination with the nursing staff.

Program Objectives

General Objective:

Enhancing nurses' knowledge and practical skills related to caring for patients receiving tPA.

Specific Objectives:

By the conclusion of the program, nurses were expected to demonstrate the ability to:

- Define stroke.
- Identify different types of strokes.
- List the causes of stroke.

- Describe the mechanism of action of tPA.
- Recognize the side effects associated with tPA.
- Outline the criteria for administering tPA.
- Perform the essential nursing procedures required for safe tPA administration.

Phase III: Implementation Phase

The educational and training sessions were scheduled according to nurses' availability. Participants were organized into ten groups of 4–5 nurses each. The program consisted of five sessions in total, including two sessions covering theoretical content and three sessions devoted to practical skill development.

The theoretical sessions addressed the necessary knowledge, while the practical sessions involved demonstration and repeated practice of standard procedures under supervision to ensure competence and confidence. Each session lasted 45–60 minutes and included time for discussion based on participants' engagement. Every session began with a brief review of previous material followed by the objectives for the day.

Motivational techniques and reinforcement strategies were used throughout the training to promote active participation. Each nurse received an illustrated Arabic-language instructional booklet to support learning and review. All groups attended the full sequence of sessions.

Theoretical Sessions:

Session 1: Introduction to the program and explanation of stroke definition, causes, types, risk factors, and complications.

Session 2: Information on intravenous recombinant tPA, including its

mechanism, trade names, dosage, route of administration, side effects, eligibility criteria, and warning signs that require immediate cessation of the infusion.

Practical Sessions:

Session 1: Nursing care required before administering tPA.

Session 2: Nursing care practices during tPA infusion.

Session 3: Nursing care required after tPA administration.

Phase IV: Evaluation Phase (Post-Test Assessment)

Immediately following completion of the educational program, evaluation was conducted using the same tools applied at baseline. Nurses' knowledge and practice were reassessed using the structured questionnaire and performance checklist, while the study group of patients was evaluated with Tool III to measure clinical risk and stroke severity post-intervention. Comparison of pre- and post-intervention results allowed the researchers to establish the effectiveness of the educational program in improving nurses' competencies and enhancing patient outcomes.

Data analysis:

Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 25. Quantitative data were described using the mean, standard deviation (SD), and range, while qualitative data were reported as frequencies and percentages. Associations between categorical variables were evaluated using the Chi-square test. Differences in mean scores between groups were assessed using the independent t-test. Pearson's correlation coefficient was employed to examine relationships between continuous variables. Furthermore, linear regression analysis was conducted to identify predictors of

clinical risk, with the clinical risk score treated as the dependent variable. A p-value of ≤ 0.05 was considered statistically significant.

Results

Table 1 demonstrates that most of the participating nurses (80%) were younger than 30 years, with a mean age of 26.66 ± 6.73 years, and 60% were females. More than half (62%) held a technical nursing qualification, and 70% had fewer than five years of experience in the stroke unit, with a mean of 1.40 ± 0.67 years. Additionally, 78% had never received any previous training related to caring for stroke patients receiving tissue plasminogen activator.

Table 2 demonstrates that, prior to implementation of the educational program, nurses generally exhibited unsatisfactory knowledge regarding stroke (its definition, types, causes, and complications) and the principles of intravenous tPA administration. Only 78%, 64%, 60%, and 58% of nurses showed satisfactory knowledge concerning their roles before, during, and after tPA administration. Following the program, the proportion of nurses achieving satisfactory knowledge increased significantly to 94%, 76%, 82%, and 88%, respectively, with statistically significant improvements ($p < 0.001$, 0.003, 0.007, 0.002).

Figure 1 illustrates the overall knowledge levels before and after the educational intervention, revealing that 88.0% of nurses attained satisfactory knowledge immediately after the program compared to only 20% beforehand with a statistically significant difference ($p = 0.047$).

Table 3 indicates that, prior to the program, only 40%, 48%, and 36% of nurses demonstrated adequate practice related to pre-, during-, and post-administration care of intravenous

recombinant tPA. After educational program implementation, these rates improved markedly to 72%, 86%, and 80%, respectively, with significant differences between pre- and post-intervention scores ($p < 0.001$, 0.006, 0.008).

Figure 2 shows that 84% of nurses demonstrated adequate practice immediately post program compared with 34% pre intervention—a statistically significant improvement ($p = 0.027$).

Table 4 presents the correlation between nurses' total knowledge and practice scores, showing a statistically significant positive relationship at both assessment points ($r = 0.390$, $p = 0.005$ and $r = 0.564$, $p < 0.001$, respectively).

Table 5 compares the sociodemographic data of stroke patients in the two studied groups. In both groups, most participants were aged 40 to <50 years (77.5% in the control group and 87.5% in the study group), with mean ages of 45.225 ± 5.599 and 47.700 ± 6.110 years. Males constituted 77.5% of the control group and 85% of the study group, while 85% and 70% of each group, respectively, were married. Most patients had an intermediate level of education (60% and 75%), and 62.5% and 67.5% of the control and study groups lived in urban areas. No statistically significant differences were found between the two groups regarding their demographic data.

Table 6 illustrates the comparison of medical data of studied patient groups, indicating that 55% and 52% of control and study groups, respectively, were admitted at the first 30–60 minutes of stroke symptoms onset. 62.5% and 70%, respectively, suffered from high cholesterol levels as a risk factor. Furthermore, 55% and 60%, respectively, of control and study groups admitted with hemiparesis as clinical manifestation. Additionally,

35% and 47.5% of both groups initiated tPA infusion at 31–60 minutes of admission with non-statistically significant difference between the two groups regards all medical related characteristics.

Table 7 illustrates that, during different times of tPA administration control group experienced a high clinical risk score 32.5%, 27.5%, 22.5%, and 17.5%. While, these scores were low among study group 7.5%, 17.5%, 10%, & 5% with highly significant statistical difference observed as p -value = 0.044 and 0.029 at post 6 hours, and post 12 hours.

Figure 3 illustrates that, during the different times of tPA administration, control group of patients experienced a very severe level of stroke 85%, 72.5%, 72.5%, and 67.5% respectively. While this level score was low among study group 90%, 45%, 32.5%, & 10% respectively with highly significant statistical difference observed as p -value ≤ 0.001 at post 2 hours, post 6 hours, and post 12 hours.

Table 8 shows that, during different times of tPA administration mean stroke severity control group experienced 31.40 ± 9.76 , 29.22 ± 11.41 pre-educational program implementation While, these mean were deamination among study group 24.72 ± 10.55 , 16.90 ± 7.83 post-educational program implementation with highly significant statistical difference observed as p -value = 0.004 and 0.001 at post 6 hours, and post 12 hours

Table 9 Multivariate linear regression model in this table presents that clinical risk among studied patients was best predicted by age, smoking, admission arrival, nurses' knowledge as well as practice (p value = 0.041, 0.020, < 0.001 , < 0.001 and 0.001, respectively), accounting for 75.8 % of the variance of clinical risk among the studied patients.

Table (1): Frequency and percentage distribution of the studied nurses' personal features (n = 50).

Nurses' personal data	(n = 50)	
	No.	%
Age / years		
<30	40	80.0
30 - < 40	8	16.0
40- 50	2	4.0
Mean ± SD	26.66 ± 6.73	
Sex		
Male	20	40.0
Female	30	60.0
Educational level		
Nursing Diploma	8	16.0
Technical institute of Nursing	31	62.0
Bachelor degree of Nursing	11	22.0
Years of Experience (in years)		
< 5	35	70.0
5- 10	10	20.0
>10	5	10.0
Mean ± SD	1.40 ± 0.67	
Attending previous training courses related to of stroke patients who administrated tissue plasminogen activator.		
Yes	11	22.0
No	39	78.0

Table (2): Comparison of total nurses' knowledge score pre and immediately post educational program implementation (n=50).

Nurses' knowledge	Knowledge level	Pre- program implementation n= 50		Immediately post program n= 50		X ² test P value
		(No.)	%	(No.)	%	
Definition of stroke and its types	Satisfactory ≥ 80%	11	22.0	47	94.0	16.555 <0.001
	Unsatisfactory < 80%	39	78.0	3	6.0	
Stroke causes and its complications	Satisfactory ≥ 80%	18	36.0	38	76.0	8.882 0.003
	Unsatisfactory < 80%	32	64.0	12	24.0	
tissue plasminogen activator and its administration precautions	Satisfactory ≥ 80%	20	40.0	41	82.0	7.317 0.007
	Unsatisfactory < 80%	30	60.0	9	18.0	
Nursing role pre, during and after plasminogen activator administration	Satisfactory ≥ 80%	29	58.0	44	88.0	9.416 0.002
	Unsatisfactory < 80%	21	42.0	6	12.0	

Figure (1): Difference of total knowledge level among the studied nurses pre and post educational program implementation (n=50).

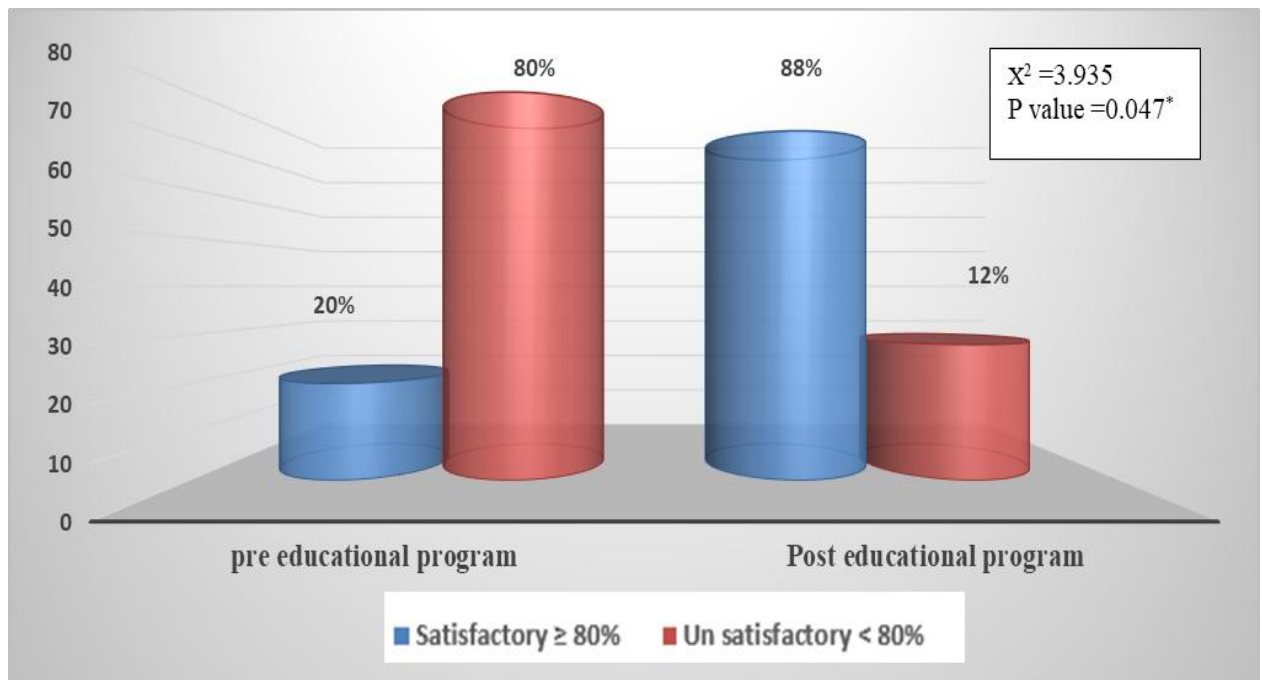


Table (3): Comparison of total nurses' practice score pre, during, and after administration of intravenous recombinant tissue plasminogen activator pre and immediately post educational program implementation (n=50)

Nurses' practice	Practice level	pre - program n= 50		immediately post program n= 50		X ² test P value
		(No.)	%	(No.)	%	
Pre plasminogen activator administration	Adequate $\geq 85\%$	20	40.0	36	72.0	12.963 <0.001
	In adequate $< 85\%$	30	60.0	14	28.0	
During plasminogen activator administration	Adequate $\geq 85\%$	24	48.0	43	86.0	7.513 0.006
	In adequate $< 85\%$	26	52.0	7	14.0	
After plasminogen activator administration	Adequate $\geq 85\%$	18	36.0	40	80.0	7.031 0.008
	In adequate $< 85\%$	32	64.0	10	20.0	

Figure (2): Difference of total practice level among the studied nurses pre and post educational program implementation (n=50)

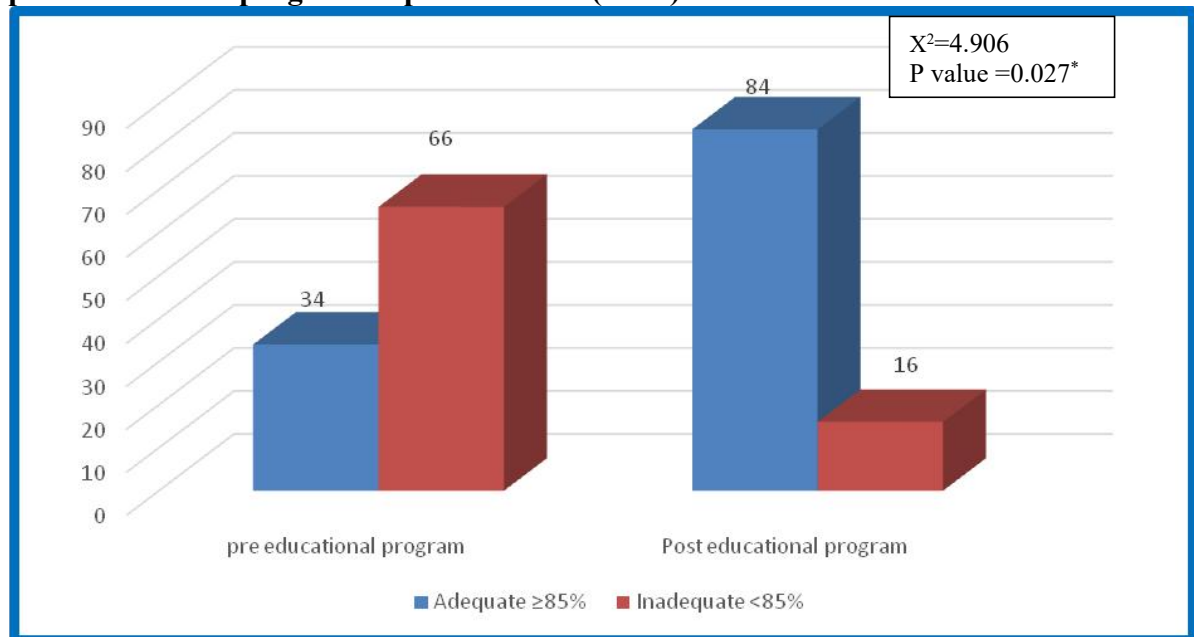


Table (4) Correlation between total knowledge, and practice among the studied nurses pre and post educational program implementation (n=50)

Variable	r\ p values	Periods	Total knowledge	
			R	P
Total practice		Pre program	0.390	0.005
		Post program	0.564	<0.001

Table (5): Comparison of the studied patients based on their socio demographic data (n= 80).

Patients’ socio demographic data	Control group (Pre educational program implementation) (n= 40)		Study group (Post educational program implementation) (n= 40)		X ² P value
	No.	%	No.	%	
Age (in years)					3.220 0.200 ^{n.s}
20- <30	2	5.0	3	7.5	
30 - <40	7	17.5	2	5.0	
40 – <50	31	77.5	35	87.5	
Mean ± SD	45.225± 5.599		47. 700± 6.110		T=-1.889 P= 0.063 ^{n.s}
Gender					0.738
Male	31	77.5	34	85.0	0.390 ^{n.s}
Female	9	22.5	6	15.0	
Marital status					6.369 0.095 ^{n.s}
Single	3	7.5	1	2.5	
Married	34	85.0	28	70.0	
Widowed	2	5.0	9	22.5	
Divorced	1	2.5	2	5.0	
Level of Education					4.542 0.209 ^{n.s}
Illiterate	5	12.5	2	5.0	
Intermediate Certification	24	60.0	30	75.0	
Highly educated	11	27.5	8	20.0	
Residence					0.220
Rural	15	37.5	13	32.5	0.639 ^{n.s}
Urban	25	62.5	27	67.5	
Smoking habit					0.912
Yes	29	72.5	25	62.5	0.474 ^{n.s}
No	11	27.5	15	37.5	

Table (6): comparison of the studied patients according to their medical data related to stroke (No.=80).

Medical data	Items	Control group (Pre educational program implementation) (n= 40)		Study group (Post educational program implementation) (n= 40)		X ² P value
		No.	%	No.	%	
Time of admission to hospital since symptoms onset in minutes	30-60 min	22	55.0	21	52.5	2.718 0.437 ^{n.s}
	61-90 min	9	22.5	12	30.0	
	91-120min	7	17.5	3	7.5	
	121-150min	2	5.5	4	10.0	
Risk factors	High cholesterol	25	62.5	28	70.0	0.813 0.846 ^{n.s}
	Hypertension	6	15.0	6	15.0	
	Diabetes	5	12.5	3	7.5	
	Cardiac disease	4	10.0	3	7.5	
Clinical manifestation	Hemiparesis	22	55.0	24	60.0	3.378 0.337 ^{n.s}
	Speech troubles	9	22.5	11	27.5	
	Facial weakness	6	15.0	5	12.5	
	Visual disturbance	3	7.0	0	0.0	
Initiation Time of TPA administration in minutes	0-30min of admission	6	15.0	11	27.5	5.800 0.122 ^{n.s}
	31-60min of admission	14	35.0	19	47.5	
	61-90min of admission	10	25.0	4	10.0	
	91-120min of admission	10	25.0	6	15.0	

Table (7): Difference of the studied patients according to their clinical risks score during the different times of TPA administration (n=80)

Patient' health outcomes (Clinical risk score)	Control group (Pre - program implementation) (n= 40)			Study group (Post program implementation) (n= 40)			X ² P value
	Low risk (1-4)	Medium risk (5-6)	High risk (≥ 7)	Low risk (1-4)	Medium risk (5-6)	High risk (≥ 7)	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Pre administration	10(25.0)	17(42.5)	13(32.5)	8(20.0)	21(52.5)	11(27.5)	0.810 0.667 n.s
Post 2hrs of administration	13(32.5)	16(40.0)	11(27.5)	18(45.0)	15(37.5)	7(17.5)	1.728 0.422 n.s
Post 6hrs of administration	16(40.0)	15(37.5)	9(22.5)	27(67.5)	9(22.5)	4(10.0)	6.237 0.044*
Post 12hrs of administration	21(52.5)	12(30.0)	7(17.5)	32(80.0)	6(15.0)	2(5.0)	7.061 0.029*

Table (8): Difference of mean score of stroke severity among the studied patients during the different times of TPA administration (n=80)

Patient' health outcomes (stroke severity score)	Control group (Pre - program) (n= 40)	Study group (Post program) (n= 40)	T test	P value
	X ± SD	X ± SD		
Pre administration	37.35±7.75	38.25±6.45	-0.564	0.574 n.s
Post 2hrs of administration	31.82±9.84	28.00±10.54	1.677	0.098 n.s
Post 6hrs of administration	31.40±9.76	24.72±10.55	2.935	0.004*
Post 12hrs of administration	29.22±11.41	16.90±7.83	5.631	<0.001**

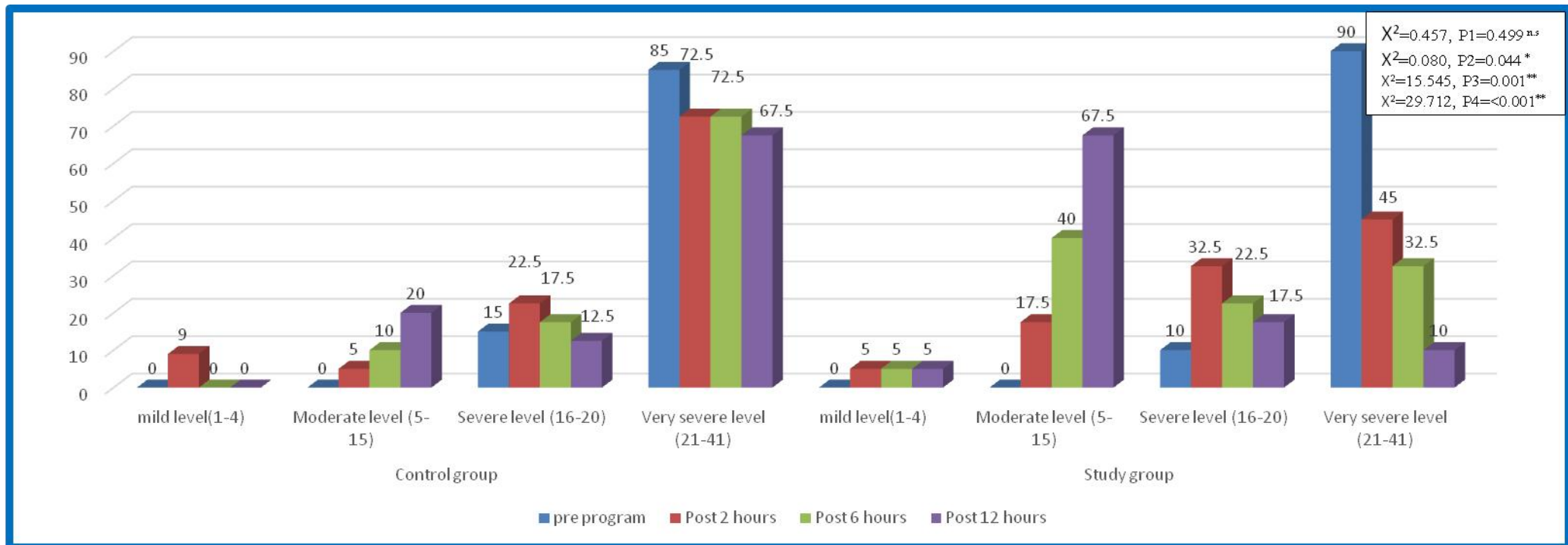


Figure 3. Difference of stroke severity level among the studied patients during the different times of TPA administration pre- and post-educational program implementation n(80).

- (1) control group versus study group pre administration
- (2) control group versus study group post 2 hours of administration
- (3) control group versus study group post 6 hours of administration
- (4) control group versus study group post 12 hours of administration

Table (9): Multiple Linear Regression Analyses for Predictor Variables of patients' clinical risk post educational program implementation (n=80)

Predictor Variable Of patients' clinical risk	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.733-	2.215		-.331-	.742
Age	-.593-	.282	-.190-	-2.101-	.041*
Smoking	-2.283-	.945	-.306-	-2.416-	.020*
Admission arrival	-4.718-	1.233	-.517-	-3.825-	.000**
Time of symptom treatment	.216	.237	.085	.911	.365
Stroke severity	-.252-	.175	-.138-	-1.443-	.153
Nurses' knowledge post program	.390	.039	1.217	9.986	.000**
Nurses' practice post program	.091	.026	.300	3.441	.001**
Adjusted R ² = 0.758			P = <0.001**		

(B) Beta Co-Efficient

(SEB) Standard Error

Discussion

Stroke continues to be a major global health burden, ranking among the foremost causes of death and long-term disability worldwide. Approximately 16% of affected individuals die from the condition, while around 20% experience long-term functional impairments that leave them reliant on caregivers for daily activities (Mohamed et al., 2021). Recombinant tissue plasminogen activator (rtPA) is the primary and most effective thrombolytic therapy for patients with acute ischemic stroke. The initial hours following stroke onset are critically important, as rapid neurological decline can occur during this period (Catangui, 2019). Timely intervention during these early hours strongly influences patients' recovery, prognosis, and overall reduction in morbidity and mortality. Therefore, nurses must possess comprehensive knowledge of the safe dosage, proper administration techniques, and essential considerations for tPA therapy. Their level of awareness and the quality of nursing care provided to patients receiving tPA are pivotal in improving clinical outcomes (Williams, 2020).

The demographic features of the participating nurses revealed that over three-quarters were younger than 30 years, with a mean age of 26.66 ± 6.73 years. This may reflect the tendency for younger nurses to be assigned to direct patient care roles, while older and more experienced nurses often hold supervisory or administrative positions. Additionally, more than half of the sample were females, which aligns with long-standing cultural perceptions in Egypt that nursing is predominantly a female profession, given that the field has historically attracted far more women than men.

Regarding educational preparation, the study demonstrates that above half of the studied nurses held a technical nursing qualification. Most were recently graduated, which correlated with their limited professional experience; more than two-thirds reported fewer than five years of work experience in the stroke care unit. Furthermore, a substantial majority (over three-quarters) had not received any prior training related to caring for stroke patients undergoing tPA administration.

These results are agreeing with several recent studies. Al-Abedi et al. (2022) similarly reported that above half of their

studied nurses aged 25–29 years and that female nurses outnumbered males. **Abd El-Hay et al. (2018)** also documented a higher proportion of female nurses in both their study groups. **Mohammed et al. (2021)** found that half of their sample held technical nursing institute diplomas.

Likewise, **Safwat et al. (2021)** observed that nearly fifty percent of their studied nurses were recent graduates aged between 20 and 30 years and that most had not attended any training related to tPA administration, possibly due to staffing shortages and increased workload. Comparable findings were also reported by **Khattab (2019)**, who noted that about half of the nurses caring for stroke patients during the golden hours were younger than 30. Similarly, **Abd Elstar et al. (2019)** found that most participating nurses were females and held technical nursing qualifications.

Abd El-Hady et al. (2022) reported similar findings in their study on challenges faced by critical care nurses, noting that most participants were graduates of technical nursing institutes. Conversely, the results differ from those of **Darvesh & Butcher, (2022)**, who observed that half of the nurses in their sample held bachelor's degrees, highlighting variation across different healthcare environments.

The current study further revealed that only a minority of nurses initially possessed satisfactory knowledge about stroke and the administration of intravenous recombinant tissue plasminogen activator. However, following the educational program, nurses demonstrated a substantial and statistically significant improvement, with most attaining satisfactory knowledge levels.

Overall, the pre-intervention results revealed that most nurses possessed inadequate knowledge and insufficient understanding of stroke care and the procedures associated with tPA administration. Several factors may explain this deficit: tPA is a relatively recent

advancement in stroke management; many nurses have not received formal training specific to tPA administration; and opportunities for continuing education or specialized instruction in stroke nursing care are limited. Consequently, nurses relied mainly on theoretical content learned during their academic studies, without exposure to practical, evidence-based standards for care before, during, and after tPA infusion.

Following the educational program, nurses exhibited substantial improvement in their comprehension and application of essential concepts. This enhanced performance is likely attributable to increased awareness of clinical standards, structured reinforcement during training sessions, and the use of varied teaching methods—including illustrated Arabic booklets and audiovisual materials—that facilitated understanding. Participation in training sessions focused on the management of stroke patients receiving tPA also enabled nurses to develop greater confidence and competence in providing safe and effective care, thereby supporting the first research hypothesis.

These results align with previous literature. **Abd El-Hay et al. (2018)** reported significant improvements in nurses' knowledge following implementation of an ischemic stroke nursing management protocol. Similarly, **Abd Elmegeid et al. (2020)** found that only one-third of nurses who had not attended educational sessions demonstrated satisfactory knowledge regarding acute ischemic stroke care, reinforcing the need for structured training. These results are also agreed with **El-Sayed et al. (2016)**, who observed that most nurses had poor knowledge level before an educational intervention for cerebrovascular stroke care.

Safwat et al. (2021) likewise documented inadequate pre-intervention knowledge among nurses caring for ischemic stroke patients during tPA administration. Comparable results were

reported by **Khalil et al. (2018)**, who reported that most nurses lacked adequate knowledge of tPA preparation and safety precautions. **Abd Elmegeid (2020)** further confirmed that above half of their studied nurses demonstrated insufficient knowledge about the care of stroke patients.

Regarding overall nurses' performance in caring for stroke patients receiving tissue plasminogen activator, the present study demonstrated a substantial improvement following the educational intervention. Immediately after the program, most nurses achieved an adequate level of practice, compared with only slightly more than one-third prior to the intervention—a difference that was statistically significant. These results reinforce the second research hypothesis, confirming the positive effect of the educational program on nursing practice.

The study also identified a statistically significant positive correlation between nurses' total knowledge scores and their practice scores both pre and post educational program implementation. This finding is consistent with **Safwat et al. (2021)**, who reported a fair positive relationship between nurses' knowledge and practices when caring for patients receiving recombinant tissue plasminogen activator, emphasizing that competence in practice improves as knowledge increases. Similarly, **Abd El-Hady et al. (2022)** reported substantial enhancements in nurses' knowledge and clinical performance following the implementation of a cerebrovascular stroke care program. Similarly, **Khalil et al. (2020)** identified a strong and statistically significant positive association between nurses' overall knowledge and their practice throughout the various phases of their study. Together, these studies support the conclusion that enhanced knowledge directly contributes to improved clinical practice, thereby affirming the research hypothesis.

Regarding the demographic features of the patients, the findings of the current study showed that above half of the

participants in both groups were between 40 and <50 years, with mean ages of 45.225 ± 5.599 and 47.700 ± 6.110 years, respectively. The majority were males, which may be attributed to higher exposure to stressors, hypertension, smoking, and socioeconomic pressures that could increase stroke risk. Most patients in the control group and over two-thirds in the study group were married. Additionally, more than half of the patients lived in urban settings, where lifestyle factors—such as limited physical activity, increased psychological stress, and higher likelihood of overweight and elevated cholesterol—may contribute to greater stroke incidence. Additionally, approximately two-thirds or more of the patients possessed an intermediate educational level.

The current study findings were agreed with **Hamed et al. (2024)**, who revealed that most patients were aged 50–60 years, predominantly males, about half were married, and three-quarters had education below the diploma level. Similarly, **Tork et al. (2020)** found that more than two-thirds of their sample were males. Conversely, **Hamid et al. (2024)** observed a higher proportion of female patients, while **Hadianfar et al. (2023)** supported the present study by noting that most patients resided in urban areas.

With respect to medical data, half of the patients in both groups presented to the hospital within 30–60 minutes of stroke onset. More than half exhibited high cholesterol levels as a major risk factor. Hemiparesis was the most common clinical manifestation in both groups, occurring in approximately half of the patients. Additionally, one-third of each group received tPA between 31–60 minutes after ischemic stroke diagnosis.

These findings are agreed with **Tork et al. (2020)**, who reported that above half of their participants had hypertension as a stroke risk factor, door-to-needle times under 60 minutes, and administration of IV rtPA within three hours of symptom onset. However, they contrast with **Mohamed et**

al. (2021), who found hypertension to be the predominant risk factor in nearly two-thirds of patients. Results are consistent with **Kummarg et al. (2018)**, who indicated that high cholesterol was a common risk factor, hemiparesis was the most frequent clinical presentation, most patients arrived within the first hour after stroke onset, and tPA was administered within three hours of diagnosis.

Regarding clinical risk scores, the findings showed that at various assessment points during tPA administration, patients in the control group exhibited higher clinical risk scores prior to the educational program, whereas the study group demonstrated markedly lower scores immediately after nurses received the intervention. These differences were highly statistically significant. This improvement may be attributed to variations in stroke type, the time between symptom onset and hospital arrival, and—most importantly—the greater competence of nurses following the educational training, which enhanced their ability to deliver prompt and effective care.

The study further revealed that the educational program had a substantial positive impact on nurses' performance compared to their pre-training levels. After the intervention, nurses demonstrated significantly greater adherence to established standards of care related to tPA administration, whereas compliance with these standards had been suboptimal before training. The improved alignment with best practices translated into better-quality care for ischemic stroke patients receiving tPA.

These findings are supported by **Ma (2022)**, who reported that implementing evidence-based guidelines improves the quality of stroke nursing care and enhances patient prognosis. Similar conclusions were drawn by **Perry et al. (2019)**, who found that adherence to nursing standards reduces clinical risk and stroke severity. Moreover, **Cappadona et al. (2023)** highlighted the critical value of auditing stroke care practices, underscoring that

nurses serve as key contributors to the safe and efficient administration of tPA therapy.

Concerning stroke severity, the study showed a notable reduction in the mean NIHSS scores among the study group: from 38.25 ± 6.45 before tPA administration, to 24.72 ± 10.55 after 6 hours, and further declining to 16.90 ± 7.83 at 12 hours post-administration. This progressive improvement was observed immediately after the educational intervention for nurses, supporting the study's third hypothesis that enhanced nursing knowledge and skills positively affect patient outcomes.

These results align with **Hamid et al. (2024)**, who emphasized that early and efficient nursing management—including timely rt-PA administration—is essential for optimizing neurological recovery and reducing delays in treatment. Likewise, **Kummarg et al. (2018)** demonstrated that earlier nursing intervention during tPA administration is associated with better clinical outcomes, noting that nurse-led case management significantly shortens door-to-needle time, which is a key determinant of patient improvement.

Conclusion

The findings of this study indicate that the educational program was highly effective in improving nurses' knowledge and clinical performance, which subsequently led to better patient outcomes. Notable improvements were observed in nurses' overall knowledge and practice scores following the intervention, and these enhancements were reflected in reduced clinical risk and lower stroke severity scores among patients who received care after the program's implementation.

Recommendations

1. Establishing a continuous and structured educational program for nurses is imperative. Such a program should be delivered regularly to strengthen their knowledge and practical skills, reinforce

adherence to nursing care standards, ensure accurate implementation of procedures, and improve the quality of care provided to stroke patients receiving tissue plasminogen activator.

2. A concise, user-friendly, and comprehensive educational booklet should be made readily accessible to nurses. This booklet should provide clear therapeutic guidelines and outline the nursing responsibilities before, during, and after tPA administration to support consistent and safe clinical practice.

References

- Abd El-Hay, S., Abed Allah, A., & Tag El Din, E. (2018).** Effect of implementing designed educational training program for neurological nurses on clinical outcomes of stroke patients. *Clinical Nursing Studies*, 6(4), 121-137.
- Abd Elmegeid, M., Hussein, Z., & Salah, H. (2020).** Emergency nurses' knowledge and practice regarding care of acute ischemic stroke patients undergoing recombinant tissue plasminogen activator. *IOSR Journal of Nursing and Health Science*, 9(5), 28-35.
- Abdelhady, S., Mostafa, M., Kandeel, N., & Ali, W. (2022).** The Effect of Implementing Ischemic Stroke Nursing Management Protocol on Critical Care Nurses' Knowledge and Practices. *Mansoura Nursing Journal*, 9(1), 223-233. doi: 10.21608/mnj.2022.259021
- AbdELstar, M., Gendy,F., & Mohamed,H. (2019).** Nurses' Performance Regarding Patient with Traumatic Head Injury in Intensive care unit. *Egyptian Journal of Health Care*, 10(1), 729-743.
- AL-Abedi, H., & Mansour, K. (2022).** Effectiveness of an interventional program on nurses' knowledge concerning nursing management for patients with stroke. *International Journal of Health Sciences*, 6(S2), 14448–14461. <https://doi.org/10.53730/ijhs.v6nS2.8790>
- Babkair, L., Safhi, R., Balshram, R., Safhei, R., Almahamdy, A., Hakami, F. & Alsaleh, A. (2023).** Nursing Care for Stroke Patients: Current Practice and Future Needs. *Nurs Rep.* 13(3):1236-1250. doi: [10.3390/nursrep13030106](https://doi.org/10.3390/nursrep13030106).
- Benha University Hospital Statistical office. (2024).** Annual Report of Stroke Patients
- Brott, T., Adams, H. P., Jr, Olinger, C. P., Marler, J. R., Barsan, W. G., Biller, J., Spilker, J., Holleran, R., Eberle, R., & Hertzberg, V. (1989).** Measurements of acute cerebral infarction: a clinical examination scale. *Stroke*, 20(7), 864–870. <https://doi.org/10.1161/01.str.20.7.864>
- Cappadona, I., Corallo, F., Cardile, D., Ielo, A., Bramanti, P., Lo Buono, V., & De Cola, M. (2023).** Audit as a tool for improving the quality of stroke care: a review. *International Journal of Environmental Research and Public Health*, 20(5), 4490.
- Catangui, E. (2019).** Improving Glasgow Coma Scale (GCS) competency of nurses in one acute stroke unit-a nursing initiative project. *Journal of Nursing Practice*, 3(1), 109-115. DOI: [10.36959/545/370](https://doi.org/10.36959/545/370)
- Darvesh, N., & Butcher, R. (2022).** Systemic Thrombolysis by Alteplase for Acute Ischemic Stroke. *Canadian Journal of Health Technologies*, 2(6).
- El Labban, M., El Zibaoui, R., Amadi, A., Zareen, T., & Khan, S. (2024).** Life-Threatening tPA-Associated Angioedema: A Rare Case Report and Critical Review. *The American Journal of Case Reports*, 25, e944221-1.
- Hadianfar, A., Sasannezhad, P., Nazar, E., Yousefi, R., Shakeri, M., Jafari, Z., & Hashtarkhani, S. (2023).** Predictors of in-hospital mortality among patients with symptoms of stroke, Mashhad, Iran: an application of auto-logistic regression model. *Archives of Public Health*, 81(1),73.
- Hamed, Y., Seddeek, M., Ahmed, A., Dawa, T., Hashem, H., Othman, A. & Shokry, A. (2024).** Factors predicting functional outcome after rtPA for patients with acute ischemic stroke. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 60(1), 17.

- Hamid, M., Shariati, A., Sheini Jaber, P., & Haghighizade, M. (2024).** Clinical audit of nursing care related to tissue plasminogen activator drug injection in patients with cerebral thromboembolic stroke: A quasi-experimental study. *Journal of Nursing Advances in Clinical Sciences*, 1(2), 97-102.
- Heldner, M., Zubler, C., Mattle, H., Schroth, G., Weck, A., Mono, M., Gralla, J., Jung, S., El-Koussy, M., Lüdi, R., Yan, X., Arnold, M., Ozdoba, C., Mordasini, P., & Fischer, U. (2013).** National Institutes of Health stroke scale score and vessel occlusion in 2152 patients with acute ischemic stroke. *Stroke*, 44(4), 1153–1157.
- Hughes, R., Tadi, P. & Bollu, P. (2020):** TPA Therapy. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK482376/>. Accessed on 1 October 2024.
- Khalil, N., Eissa, R. & Ismaeel, M. (2020):** Critical care nurses' knowledge and practices regarding dysphagia care of acute ischemic stroke patient. *World Journal of Pharmaceutical and Medical Research* 6(3), 12-18.
- Khattab, R., Ahmed, N., & Saaed, A. (2019).** Factors affecting nursing performance in caring patients with cerebral stroke during first golden hours. *Evidence-Based Nursing Research*, 1(1), 29-49.
- Kummarg, U., Sindhu, S., & Muengtawepong, S. (2018).** The early outcomes of nurse case management in patients with acute ischemic stroke treated with intravenous recombinant tissue plasminogen activator: a prospective randomized controlled trial. *Neurology research international*, 2018(1), 1717843.
- Lema, G., De Leacy, R., Fara, M., Ginsburg, R., Barash, A., Banashefski, B., Tsai, J., & Rosen, R. (2024).** A Remote Consult Retinal Artery Occlusion Diagnostic Protocol. *Ophthalmology*. 2024 Jun;131(6):724-730. doi: 10.1016/j.ophtha.2023.11.031
- Li, X., Su, F., Yuan, Q., Chen, Y., Liu, C. Y., & Fan, Y. (2023).** Advances in differential diagnosis of cerebrovascular diseases in magnetic resonance imaging: a narrative review. *Quantitative Imaging in Medicine and Surgery*, 13(4), 2712.
- Lip, G. Y., & Ntaios, G. (2022).** “Novel Clinical Concepts in Thrombosis”: integrated care for stroke management—easy as ABC. *Thrombosis and haemostasis*, 122(03), 316-319.
- Ma, S. Y. (2022).** Evaluating the impact of evidence-based nursing in combination with clinical nursing pathway for nursing care of patients with stroke: A protocol for systematic review and meta-analysis. *Medicine*, 101(2), e28278
- Maalouf, E., Hallit, S., Salameh, P., & Hosseini, H. (2023).** Eating behaviors, lifestyle, and ischemic stroke: a Lebanese case-control study. *International journal of environmental research and public health*, 20(2), 1487. doi: 10.3390/ijerph20021487.
- McGregor, M. (2024).** *Neurology Board Review*, 1st ed., Oxford University Press, USA, p 22
- Miao, Q., Yan, Y., Zhou, M. & Sun, X. (2023).** The Role of Nursing Care in the Management of Patients with Traumatic Subarachnoid Hemorrhage. *Galen Med J*. 2023 Aug 20;12:e3013. doi: 10.31661/gmj.v12i0.3013.
- Mohamed, W., Abdel Ghaffar, A., Abdel Gawad, A., & Agban, E. (2021).** Short-term outcome in ischemic stroke patients after thrombolytic therapy. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 57(1), 280-285. doi: 10.21608/zumj.2020.25949.1773
- Moore, T. and Cunningham, S. (2021).** *Nursing Skills in Cardiorespiratory Assessment and Monitoring*, 1st ed, Routledge Publisher, London, p102.
- Perry, S., Miles, A., Fink, J., & Huckabee, M. (2019).** The dysphagia in stroke protocol reduces aspiration pneumonia in patients with dysphagia following acute stroke: a clinical audit. *Translational stroke research*, 10(1), 36-43.
- Safwat., Talaat, M., & Ebrahim, N., (2021).** Nursing performance regarding monitoring of patients with ischemic stroke during

administration of tissue plasminogen activator drug. *Egyptian Journal of Health Care*, 12(4), 853-869.

Sefidkar, R. & Madadizadeh, F., (2022). A Tutorial on Quasi -Experimental Designs, *Journal of Community Health Research*; 11 (1): 3 – 4.

Shah, K., Clark, A., Desai, S., & Jadhav, A. (2022). Causes, Predictors, and Timing of Early Neurological Deterioration and Symptomatic Intracranial Hemorrhage After Administration of IV tPA. *Neurocrit Care*. 2022 Feb;36(1):123-129. doi: [10.1007/s12028-021-01266-5](https://doi.org/10.1007/s12028-021-01266-5).

Thompson, S. K. (2012). Sampling (3rd ed.). John Wiley.

Tork, M., Aref, H., El-Khawas, H., Khalil, M., & El Sadek, A. (2020). Outcome predictors of intravenous thrombolytic therapy in acute ischemic stroke patients: an Egyptian center experiences. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, 56(1), 10

Williams, J., Perry, L. and Watkins, C. (2020): stroke nursing, 2ed., India, pp. (84-87)

Yan, S., Zhou, Y., Lansberg, M. G., Liebeskind, D. S., Yuan, C., Yu, H., Chen, F., Chen, H., Zhang, B., Mao, L., Wang, X., Zhou, H., Zhong, W. ,& Wang, J. (2025). Alteplase for Posterior Circulation Ischemic Stroke at 4.5 to 24 Hours. *The New England journal of medicine*, 392(13), 1288–1296. <https://doi.org/10.1056/NEJMoa2413344>

You, S., Wang, Y., Wang, X., Maeda, T., Ouyang, M., Han, Q., Li, Q., Song, L., Zhao, Y., Chen, C., Delcourt, C., Ren, X., Carcel, C., Zhou, Z., Cao, Y., Liu, C. F., Zheng, D., Arima, H., Robinson, T. G., Chen, X.,& Anderson, C. S. (2024). Twenty-Four-Hour Post-Thrombolysis NIHSS Score as the Strongest Prognostic Predictor After Acute Ischemic Stroke. *Journal of the American Heart Association*, 13(18), e036109. <https://doi.org/10.1161/JAHA.124.036109>