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# Educational Nursing Strategies for the Management of Increased Intracranial Pressure in Children with Neurological Injury at Pediatric Intensive Care Units

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## Abstract
**Background:** Elevated intracranial pressure is a potentially devastating complication of neurologic injury in children. **Aim of the study:** To examine the effects of educational nursing strategies on the management of increased intracranial pressure in children with neurological injury. **Design:** A quasi-experimental was used. **Setting:** The study was conducted in the Pediatric Intensive Care Units at Al-Nasr Specialized Children's Hospital and Al Salam Hospital in Port Said City. **Subjects:** A convenience sample of 40 nurses caring for children with increased intracranial pressure in the previously stated settings from the period from January to June 2021. Two tools were used for data collection, **Tool I:** Self-administered structured questionnaire consists of two parts to assess nurses' knowledge. **Tool II:** An observational checklist was used to assess nurses' practice. **Results:** There were statistically significant differences between pre and post-test concerning nurses, knowledge and practice of the regarding care of children with increased intracranial pressure at 1% and 5% of statistical significance. **Conclusions:** Implementation of a nursing educational program upgraded nurses' knowledge and practice of children with increased intracranial pressure. **Recommendations:** Continuous educational programs should be planned on a regular basis for nurses caring for children with increased intracranial pressure in order to improve their knowledge and practice to provide high-quality care.

***Keywords: Children, Increased intracranial pressure, Management, Neurological injury & Nursing strategies***

## Introduction
Increased intracranial pressure (ICP) is a neurologic or neurosurgical emergency that can be fatal. Rapidly identifying and treating the underlying cause can help to avoid major morbidity and even death **(Pinto et al., 2021**). Trauma, intracranial bleeding, mass lesions, cerebral edema, increased CSF production, and impaired CSF absorption is all possible causes of elevated ICP. If not treated promptly, increased ICP can lead to brain herniation and death. Congenital illnesses, viral infections, metabolic or endocrine crises, and idiopathic intracranial hypertension are all unique etiologies in the pediatric population **(Rosenberg, 2021)**. Childhood primary angiitis of the central nervous system, a rare inflammatory central nervous system illness that poses diagnostic and therapeutic problems, is an uncommon syndrome that produces high intracranial pressure **(Al-Mansour et al., 2021)** Agitation, discomfort, and patient-ventilator asynchrony all contribute to elevated ICP **(Pinto et al., 2021).**

The cranium is a rigid structure comprising of three core elements: brain, cerebrospinal fluid, and blood **(Graham, 2019)**. Normal values in children vary according to their age. While there is still some disagreement on age-specific techniques, it is generally agreed that transient rises in ICP that return to normal in 5 minutes are unimportant; nevertheless, sustained increases of 20 mm Hg for 5 minutes should almost certainly necessitate therapy when compared to adults **(Pedersen et al., 2020)**. The increased pressure inside the skull, increased cranial vault volume might cause a reduction in cerebral blood flow or herniation of the brain. It can also result in disability and a higher mortality rate. The pressure inside the cranial vault is measured in millimeters of mercury (mmHg), and it's usually less than 20 mmHg. Children's intracranial pressure ranges from 3 to 7 mmHg, whereas infants' ranges from 1.5 to 6 mmHg **(Ragland & Lee, 2016)**.

The several clinical indicators of elevated ICP include headache, nausea and vomiting, blurred vision, and papilledema. Computed Tomography (CT) outcomes expressive of either increased ICP or reduced intracranial compliance reserve include midline shift, obliteration of the basal cisterns, loss of sulci, ventricular effacement (or enlarged ventricles in the event of hydrocephalus or ventricular trapping). Edema appears on a CT scan as a region of hypodensity. The basal cisterns look on CT as a dark (hypodense fluid) halo about the upper end of the brainstem **(Lemkuil et al., 2020).**

Management of increased intracranial pressure is aimed at relieving pressure on the brain and preventing secondary injury caused by inadequate blood flow **(Shimony et al., 2021)**.

The three therapeutic goals of the first level of therapy are to prevent and/or treat intracranial hypertension, optimize cerebral perfusion pressure, and optimize partial pressure of brain tissue oxygen (when monitored). The second level of treatment includes decompressive craniotomy surgery, barbiturate infusions, late hypothermia, induced hyperventilation, and hyperosmolar treatments (**Kochanek et al., 2019).** The cornerstone of neurocritical care understands how to employ intracranial pressure (ICP) monitoring and how to administer the proper intervention for ICP increase to assure adequate brain perfusion. Preventing secondary brain injury necessitates careful treatment of the relationship between cerebral and systemic physiology, particularly in disorders of cerebral autoregulation **(Sing & Cheng, 2021).** In addition, Physical, occupational, and speech-language therapy can help the patient maximize function after the brain injury. The prognosis of children depends upon the underlying cause and the severity of the disease **(Sacco & Delibert, 2018).**

Successful nursing management of infants with increased ICP necessitates early detection and treatment aimed at lowering ICP while also addressing the underlying cause. Early detection of a raised ICP can help to avoid neurologic complications and death **(Changa et al., 2019**). The pediatric intensive care nurse should be aware of some methods to lower intracranial pressure include elevating the head of the bed to 30 degrees to make the most of venous drainage with least tolerate of cerebral perfusion (Geeraerts et al., 2018). Hyperventilation to conserve the $Paco_2$ among 27 and 30 mmHg can cause cerebral vasoconstriction and a decline in cerebral blood volume. Use of Osmotic agents such as Mannitol and Corticosteroids to create the intravascular space hyperosmolar to the brain and allow water to flow movement of water from brain tissue into the intravascular compartment (**Rodrigo et al., 2020).**

Nurses in PICU are responsible for maintaining neurophysiological and hemodynamic parameters as well as preventing increasing intracranial pressure **(De Almeida et al., 2019).** In order to advance the care and decrease iatrogenic occurrences that could threaten the patient's clinical course and safety, they should avoid causing unnecessary injury during interventions. Also, Nurses in the PICU should be aware of changes in neurologic state, vital signs, intake, and output since some basic nursing management, including bed baths, positioning, and oral suction, can raise intracranial pressure **(Smith & Amin-Hanjani, 2019).** So, any indication and symptoms of increasing intracranial hypertension should be noted. Nurses must explain the impact of environmental and external stimuli on the patient's ICP and how to restrict stimulation to lower elevated intracranial pressure to patients and parents to avoid future concerns after discharge (**Changa et al., 2019**).

## Significance of the study

The Centres for Disease Control and Prevention (CDC) predicts that 1.5 million Americans decease each year as a result of a traumatic brain injury (TBI) linked to ICP **(Kilgore et al., 2017).** Severe TBI is a leading cause of death and disability among children with an estimated 40–60% of survivors experiencing long-term neurologic impairments **(Murphy et al., 2017).** In the general population, the incidence of idiopathic intracranial hypertension is around 0.9 to 1.0 per 100,000. In the United States, the typical age of those who have had a TBI is 15 to 19 years old **(Georges & Das, 2022).**

Pediatric nurses could benefit in a variety of ways by involvement knowledge and practices related to ICP nursing care. It has the potential to assist pediatric nurses in their crucial role in ICP nursing management. It could also boost awareness and drive for future research in this area, leading to better outcomes for children and shorter hospital stays. The education of Pediatric nurses is an important part of managing a child with ICP. All pediatric nursing professionals involved in any aspect of the children's care and management must have completed the required training and proven competence. Pediatric nurses must have a high degree of education because they are in such high demand. It improves the quality of care, reduces the likelihood of difficulties, and expedites children's rehabilitation.

**Aim of the study:**

The aim of this study is to examine the effects of educational nursing strategies on the management of increased intracranial pressure in children with neurological injury. This has been accomplished by the following specific objectives:

1. Assess the level of nurses' knowledge regarding the care of children with increased intracranial pressure.
2. Assess the level of nurses' practice regarding the care of children with increased intracranial pressure.
3. Design and implement educational nursing strategies regarding the management of children with increased intracranial pressure.
4. Evaluate the effects of educational nursing strategies on nurses' performance after implementation of educational nursing strategies.

**Research hypothesis**: The implementation of an educational nursing strategies advance nurses' knowledge and practice concerning the care of children with increased intracranial pressure.

## Subjects and Methods

**Research design**: A quasi-experimental design was carried out to complete this study.

**Setting:** The study was conducted in the Pediatric Intensive Care Units at Al-Nasr Specialized Children's Hospital and Al Salam Hospital in Port Said city

**Sample**: A convenient sample of forty nurses who provide direct care to children with increased intracranial pressure in the above-stated setting.

**Tools of Data Collection**

The following two tools were utilized to acquire data relevant to this study:

**A self-administered structured interview questionnaire sheet:** it was created by the researchers in easy Arabic language to get up all nurses levels after studying the literature on the management of children with increased intracranial pressure. It included two parts:

**Part one:** it was focused on socio-demographic characteristics of studied nurses including age, educational level, years of experience, and attendance of previous training programs about increased intracranial pressure.

**Part two:** it was used to assess nurses' knowledge regarding increased intracranial pressure before and after the nursing intervention. It was distributed with evaluating nurses' knowledge concerning these items: definition of increased intracranial pressure, normal range, the volume of intracranial pressure, causes & risk factors, signs & symptoms, diagnostic measures, complications, and nursing management.

**Scoring systems**

**Regarding (Part two**) nurses' knowledge related to increased intracranial pressure. The nurses 'answers were checked with model key answers prepared by the researchers where the correct answer was scored "one", while "zero" was given for incorrect answers or don't know. The scores of the items were added up and the total score was divided by the number of the items. These scores were converted to a percentage. The total nurses' knowledge was categorized into satisfactory knowledge was ≥ 75% and unsatisfactory ≤ 75%.

**Observational checklist**: This tool was adopted and developed by the researchers following a review of the relevant literature, which was used to evaluate the performance of nurses regarding the care of children with increased intracranial pressure. An observational checklist was adopted from **Bowden & Greenberg, (2012); Kyle & Carman, (2013); Hockenberry et al., (2017); Perry et al., (2014).** It was designed to assess nurses' practices when caring for children with increased intracranial pressure which included the following:

A- Maintaining a patent airway (7 steps),
B- Achieving an adequate breathing pattern (4 steps),
C- Optimizing cerebral tissue perfusion (which included I- proper positioning (7steps) II- minimizing environmental stimuli (3),
D- Maintaining negative fluid balance (10 steps),
E- Monitoring for more increase in ICP and potential complications (15 steps).

**The scoring system**

The observation checklist was filled out by the researchers based on nurses' practice. Each step done correctly was scored "one" and "zero" for not done or incorrectly done for each procedure, the scores of the items were added up and the total was divided by the number of the items. These scores were converted to a percentage. The practice was considered adequate if the score was ≥75% or inadequate practices if the score was ≤ 75 %.

**Reliability:**

The instrument's reliability was used to determine the extent to which items in the questionnaire were related to each other. It was computed using Cronbach's Alpha =.541 for the Nurses' Knowledge Questionnaire and Alpha = 0.85 for Observational Checklist.

**Validity:**

The instrument was handed to five juries including two professors of pediatric nursing, two assistant professors of pediatric nursing, and one assistant professor in Pediatrics for validity assure. The changes were made to ensure their relevance and completeness.

**Ethical considerations:**

Informed verbal consent was attained from the nurses sharing in this study after an explanation of the study purpose. Confidentiality and anonymity of nurses' data were assured through rendering all data & clarifying that participation in the study was voluntary and nurses could withdraw from the study.

**Pilot study:**

A Pilot study was carried out on 10% (4 nurses) of the sample selected and interviewed to test the practicability, applicability, consistency, clarity, and feasibility of the tool to estimate the needed time to fill them. It was included in the study subject.

**Fieldwork**

- The director of the hospital agreed official approval to conduct the study after receiving an official letter from the Dean of the Faculty of Nursing outlining the study's goal as well as the data assembly procedure. A meeting with the setting's director was held in order to get permission to conduct research for demonstration purpose.
- The researchers introduced themselves to the nurses who were participating in the research. (Forty nurses) and clarified the purpose. The data were collected in the period from January 2021 to June

2021 in the Pediatric Intensive Care Units at Al-Nasr Specialized Children's Hospital and Al Salam Hospital in Port Said City. This period of time was divided into:

**Assessment phase "pretest":**

The study tools were applied to evaluate nurses' knowledge and practices about increased intracranial pressure of children such as a pre-test before the nursing intervention. According to their availability, the researcher questioned each nurse individually and asked them to answer and fill out a self-administered questionnaire sheet about their knowledge. The pretest was done by using an observation checklist to assess the nurses' performance before the implementation of the nursing intervention. The nurses were observed four days per week and 4 hours \ day in the morning and afternoon. Each nurse was observed directly for the same procedure three times.

**Program construction:**

It was created by researchers following a survey of the many types of literature **(Moore et al., (2015); Caglar & Qwan, (2016); Kyle & Carman, (2017) and Hockenberry et al., (2017).** It was written in an easy-to-understand Arabic language and covers the relevant theoretical aspects of management of increased intracranial pressure in the pediatric intensive care unit. It has a theoretical component that includes information on ICP (such as definition, causes, risk factors, signs, symptoms, diagnosis & complications, and nursing management). The nurses' procedures for caring for children with ICP were the focus of the practical section. demonstration and re-demonstration of methods for maintaining a patent airway, achieving an adequate breathing pattern, and optimizing cerebral tissue perfusion (i.e., proper positioning, minimizing environmental stimuli, maintaining negative fluid balance, and monitoring for further increases in cranial pressure and potential complications). Constructing the program contents was then followed by selecting the suitable teaching methods and the appropriate media for teaching.

**Program implementation**

The educational nursing strategies program was delivered throughout four weeks, each week involved four sessions, and every session took about forty-five to sixty minutes, The total number of groups was 10 groups (for every 4 nurses). The session timing was between the morning and afternoon shift or throughout the morning shift after giving the routine care in pediatric intensive care units. **The first & second sessions** were developed to explain the theoretical part. While **the third & fourth sessions** constructed to demonstrated the practical skills distributed to two sessions per week

**Evaluation phase "Post-test"**:-

After the implementation of educational nursing strategies, the post-test was implemented to decide the level of progress in nurses' knowledge & practice. At the end of each session, researchers give a summary of the important items and provide favorable verbal feedback. At the conclusion of the last session, each nurse received an Arabic instruction booklet including theoretical and practical sections.

**Data processing and analysis**

IBM Statistical Package for Social Science (SPSS) version 20 was used to analyze the data. Descriptive and analytical Procedures were performed. Quantitative data were expressed in the form of mean and standard deviation (M±SD) and analyzed by applying Chi-Squared ($\chi 2$) for comparison of normally distributed variables. Qualitative data were expressed as numbers and percentages. The level of significance was set as P-value ‹ 0.05 and a highly significant difference if $P < 0.001$.

## Results

**Table (1): Socio-demographic characteristics of studied nurses under study (No=40).**

| Demographic characteristics | | No | Percentage % |
|---|---|---|---|
| **Age (Years)** | 20 - < 30 | 10 | 25 |
| | 30 - <40 | 24 | 60 |
| | 40 and more | 6 | 15 |
| | **Mean ± SD 34±6.82** | | |
| **Educational Level** | Diploma Nursing | 9 | 22.5 |
| | Technical Nursing Institute | 16 | 40 |
| | Bachelor degree | 15 | 37.5 |
| **Years of experience** | 1 - < 5 | 10 | 25 |
| | 5 - <10 | 25 | 62.5 |
| | ≥10 | 5 | 12.5 |
| **Training program about ICP** | Yes | 0 | 0.0 |
| | No | 40 | 100 |

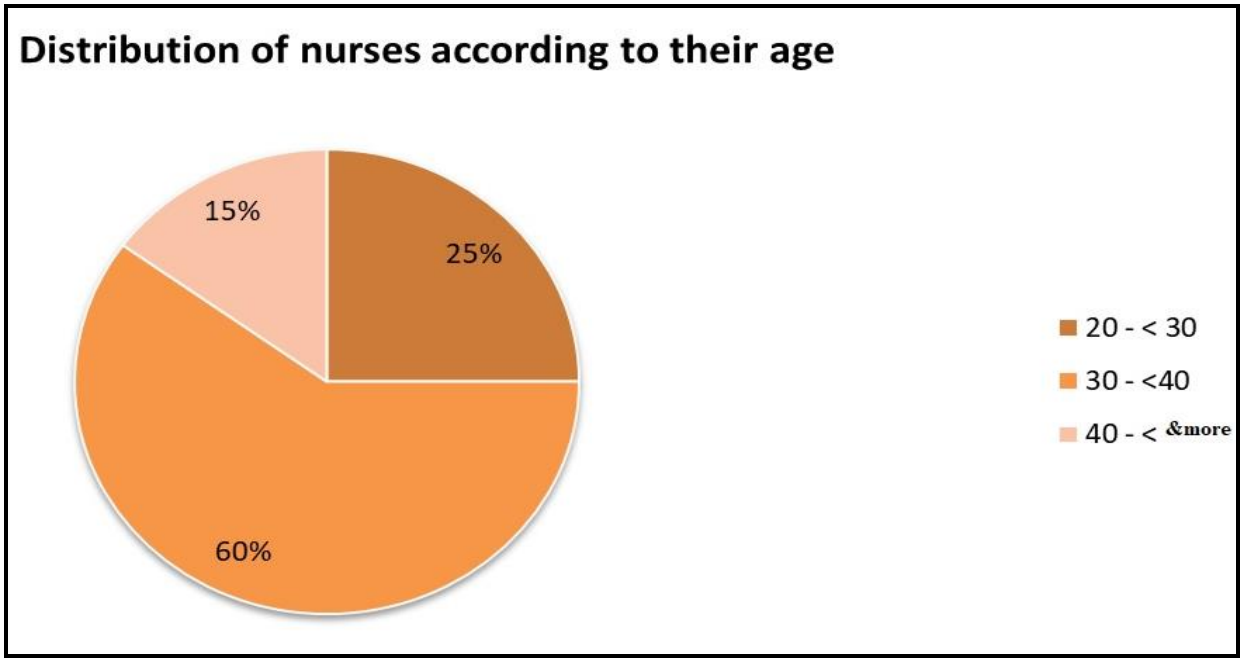


**Figure (1): Distribution of nurses according to their age.**

**Table (2): Comparison between nurses' knowledge in relation to the background of increased intracranial pressure on Pre and Post intervention (No=40).**

| Items | Nurses Knowledge | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Satisfactory | | Unsatisfactory | | Satisfactory | | Unsatisfactory | | | |
| | No | % | No | % | No | % | No | % | | |
| Definition of increased intracranial pressure | 26 | 65 | 14 | 35 | 39 | 97.5 | 1 | 2.5 | 1.90 | .168 ns |
| Volume & normal range of intracranial pressure | 27 | 67.5 | 13 | 32.5 | 38 | 95 | 5 | 5 | 4.37 | .037 ns |
| Content of skull | 25 | 62.5 | 15 | 37.5 | 39 | 97.5 | 1 | 2.5 | 1.70 | .191 ns |
| Causes and risk factors | 11 | 27.5 | 29 | 72.5 | 33 | 82.5 | 7 | 17.5 | 3.21 | .073 ns |
| Sign and symptoms | 26 | 65 | 14 | 35 | 29 | 72.5 | 11 | 27.5 | 28.17 | .000 * |
| Diagnostic measures | 13 | 32.5 | 27 | 67.5 | 36 | 90 | 4 | 10 | 9.23 | .002 * |
| Complications | 26 | 65 | 14 | 35 | 37 | 92.5 | 3 | 7.5 | 6.73 | .009 * |
| Nursing management | 10 | 25 | 30 | 75 | 28 | 70 | 12 | 30 | 28.57 | .000 * |

***NB:*** *ns means not significant* ** P=.05* *P: between pre and post-test*

**Table (3): Comparison between nurses' practice in relation to maintaining a patent airway and achieving an adequate breathing pattern on Pre and Post intervention (No=40).**

| Items | Responses | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Adequate | | Inadequate | | Adequate | | Inadequate | | | |
| | No | % | No | % | No | % | No | % | | |
| **A- Maintaining a patent airway** | | | | | | | | | | |
| Suction airway with care pre oxygenated & briefly hyperventilated 100% oxygen | 17 | 42.5 | 23 | 57.5 | 39 | 97.5 | 1 | 2.5 | .758 | .384 ns |
| Suctioning does not last longer than 15 seconds and 10 minutes rest interval | 22 | 55 | 18 | 45 | 30 | 75 | 10 | 25 | 16.29 | .000 * |
| Use open suction technique | 40 | 100 | 0 | 0.0 | 40 | 100 | 0 | 0.0 | - | - |
| Discourage coughing | 25 | 62.5 | 15 | 37.5 | 36 | 90 | 4 | 10 | 7.40 | .006 * |
| Auscultate lung \ 8 hrs | 15 | 37.5 | 25 | 62.5 | 30 | 75 | 10 | 25 | 8.0 | .005 * |
| Elevate head of bed | 14 | 35 | 26 | 65 | 31 | 77.5 | 9 | 22.5 | 6.25 | .012 ns |

| Items | Responses | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Adequate | | Inadequate | | Adequate | | Inadequate | | | |
| | No | % | No | % | No | % | No | % | | |
| **B- Achieving an adequate breathing pattern** | | | | | | | | | | |
| Monitor respiration and its irregularities | 18 | 45 | 22 | 55 | 33 | 82.5 | 7 | 17.5 | 6.94 | .008 * |
| Monitor PaCo2 (< 30 mm hg) | 25 | 62.5 | 15 | 37.5 | 37 | 92.5 | 3 | 7.5 | 5.50 | .020 |
| Monitor pulse oximeters | 23 | 57.5 | 17 | 42.5 | 34 | 85 | 6 | 15 | 9.5 | .002 * |
| Record neurological observation | 18 | 45 | 22 | 55 | 27 | 67.5 | 13 | 32.5 | 15.75 | .000 * |

***NB:*** *ns means not significant* ** P=.05* *P: between pre and post-test*

**Table (4): Comparison between nurses' practice in relation to optimizing cerebral tissue perfusion on Pre, and Post intervention (Proper position, & minimizing environmental stimuli) (No=40)**

| Items | Nurses practices | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Adequate | | Inadequate | | Adequate | | Inadequate | | | |
| | No | % | No | % | No | % | No | % | | |
| **Proper position** | | | | | | | | | | |
| Keep head in neutral (midline) position | 26 | 65 | 14 | 35 | 37 | 92.5 | 3 | 7.5 | 6.023 | .014 ns |
| Use cervical collar if necessary | 15 | 37.5 | 25 | 62.5 | 29 | 72.5 | 11 | 27.5 | 9.10 | .003 * |
| Elevate head of the bed (30- 45 degrees) | 21 | 52.5 | 19 | 37.5 | 33 | 82.5 | 7 | 17.5 | 9.37 | .002 * |
| Avoid extreme rotation of the neck | 27 | 67.5 | 13 | 32.5 | 36 | 90 | 4 | 10 | 9.23 | .002 * |
| Avoid flexion and hyperflexion of neck | 20 | 50 | 20 | 50 | 34 | 85 | 6 | 15 | 7.05 | .008 * |
| Avoid extreme hip flexion | 23 | 57.5 | 17 | 42.5 | 34 | 85 | 6 | 15 | 9.55 | .002 * |
| Hold patients' head during turning | 14 | 35 | 26 | 65 | 31 | 77.5 | 9 | 22.5 | 6.25 | .012 ns |
| **Minimizing environmental stimuli** | | | | | | | | | | |
| Clustering nursing activities | 26 | 65 | 14 | 35 | 37 | 92.5 | 3 | 7.5 | 6.023 | .014 ns |
| Avoid frequent arousal from sleep | 11 | 27.5 | 29 | 72.5 | 25 | 62.5 | 5 | 37.5 | 9.10 | .003 * |
| Maintain calm atmosphere | 20 | 50 | 20 | 50 | 32 | 80 | 8 | 20 | 10.0 | .002 * |

***NB:*** *ns means not significant* ** P=.05* *P: between pre and post*

**Table (5): Comparison between nurses' practice in relation to maintaining negative fluid balance on Pre and Post intervention (No=40).**

| Items | Nurses practices | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Adequate | | Inadequate | | Adequate | | Inadequate | | | |
| | No | % | No | % | No | % | No | % | | |
| **Assess fluid status** | | | | | | | | | | |
| Skin turgor | 25 | 62.5 | 15 | 37.5 | 38 | 95 | 2 | 5 | 3.50 | .061 ns |
| Mucous membrane | 14 | 35 | 26 | 65 | 30 | 75 | 10 | 25 | 7.17 | .007* |
| Urine Osmolarity | 28 | 70 | 12 | 30 | 36 | 90 | 4 | 10 | 10.37 | .001** |
| IV fluid administered at prescribed rate | 13 | 32.5 | 27 | 67.5 | 26 | 65 | 14 | 35 | 10.37 | .001** |
| Oral hygiene | 26 | 65 | 14 | 35 | 33 | 82.5 | 7 | 17.5 | 15.75 | .000 * |
| Glycemic control | 27 | 67.5 | 13 | 32.5 | 35 | 87.5 | 5 | 12.5 | 11.86 | .001** |
| Monitor serum glucose \4-6 hrs | 28 | 70 | 12 | 30 | 38 | 95 | 2 | 5 | 4.91 | .027* |

***NB:*** *** P=.001* *ns means not significant* ** P=.05* *P: between pre and post*

**Table (6): Comparison between nurses' practice in relation to the monitoring of potential complications on Pre and Post intervention (No=40)**

| Items | Nurses practices | | | | | | | | X2 | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | | |
| | Adequate | | Inadequate | | Adequate | | Inadequate | | | |
| | No | % | No | % | No | % | No | % | | |
| **Frequent neurological assessment** | | | | | | | | | | |
| **a- Assessment for early signs and symptoms of ICP** | | | | | | | | | | |
| Assess the level of consciousness | 15 | 37.5 | 25 | 62.5 | 32 | 80 | 8 | 20 | 6.00 | .014 ns |
| Assess pupil changes (size- reaction to light) | 20 | 50 | 20 | 50 | 35 | 87.5 | 5 | 12.5 | 5.71 | .017 ns |
| Assess weakness of extremity | 28 | 70 | 12 | 30 | 37 | 92.5 | 3 | 7.5 | 7.56 | .006 * |
| Assess headache and use pain scale | 12 | 30 | 28 | 70 | 25 | 62.5 | 15 | 37.5 | 10.28 | .001** |
| **b-Assessment for later indicators of increased ICP** | | | | | | | | | | |
| Decrease pulse | 40 | 100 | 0 | 0 | 40 | 100 | 0 | 0 | | |
| Decrease respiration | 40 | 100 | 0 | 0 | 40 | 100 | 0 | 0 | - | - |
| Increase temperature | 40 | 100 | 0 | 0 | 40 | 100 | 0 | 0 | - | - |
| Increase BP | 0 | 0 | 40 | 100 | 20 | 50 | 20 | 50 | - | - |
| Increase pulse pressure | 21 | 52.5 | 19 | 47.5 | 33 | 82.5 | 7 | 17.5 | 8.48 | .004 * |
| Altered respiratory pattern | 20 | 50 | 20 | 50 | 31 | 77.5 | 9 | 22.5 | 12.83 | .000 * |
| Projectile vomiting | 21 | 52.5 | 19 | 47.5 | 32 | 80 | 8 | 20 | 16.66 | .000 * |
| Hemiplegia & bilateral flaccidity | 25 | 62.5 | 15 | 37.5 | 37 | 92.5 | 3 | 7.5 | 1.94 | .163 ns |
| Loss of brain stem reflexes (pupillary response) | 15 | 37.5 | 25 | 62.5 | 28 | 70 | 2 | 30 | 1.94 | .163 ns |
| Decortications | 21 | 52.5 | 19 | 47.5 | 36 | 90 | 4 | 10 | 18.94 | .000 * |
| Deceleration | 22 | 55 | 18 | 45 | 32 | 80 | 8 | 20 | 5.43 | 0.20 ns |

***NB:*** ** P=.001 ns means not significant * P=.05 P: between pre and post

**Table (7): Comparison between total mean scores of nurses' knowledge and practices regarding increased intracranial pressure on Pre and Post intervention (No=40).**

| Items | Total | | P value |
|---|---|---|---|
| | Pre-test | Post-test | |
| | Mean± Standard deviation | Mean ± Standard deviation | |
| Knowledge of intracranial pressure | 4.85 ± 3.51 | 7 ± 1.82 | .000* |
| Maintaining a patent airway | 2.1±1.85 | 5.25±1.42 | .000* |
| Achieving an adequate breathing pattern | 3.27±1.28 | 3.65±3.04 | .000* |
| optimizing cerebral tissue perfusion with proper position | 1.42±1.23 | 2.35 ± .97 | .67 ns |
| Minimizing environmental stimuli | 7.0±.046 | 8.42±2.28 | .000* |
| Assess fluid status | 1.87±1.65 | 3.32±2.21 | .001** |
| Frequent neurological assessment | 6.07±2.80 | 8.92±1.96 | .031* |

***NB:*** *** P=.001* *ns means not significant* * P=.05* *P: between pre and post*

**Table (1):** Depicts the socio-demographic characteristics of studied nurses. It was illustrated that mean ± SD were 34±6.82 and the majority of nurses (62.5%) had 5 -<10 years of experience and 25% of them had 1 - < 5 years of experience. Regarding the training program, it was found that none of the studied nurses had any previous training program concerning ICP.

**Figure (1):** Reflects the distribution of nurses according to their age. It was revealed that the majority of the studied nurses (60%) aged between 30-<40 years old and 25% of them aged 20 - < 30.

**Table (2):** Reflects a comparison between nurses' knowledge in relation to the increased intracranial pressure on pre and post-test. It was revealed that the majority of nurses had satisfactory knowledge about normal range & the volume of intracranial pressure, the content of the skull, diagnostic measures, and complications were 95%, 97.5%, 90%, and 92.5% on post-test compared to 67.5%, 62.5%, 32.5%, and 65% respectively on the pre-test.

Moreover, on the pre-test, the minority of them knew the causes and risk factors (27.5 %) compared to 82.5% on the post-test. Also, there were statistically significant differences between nurses' knowledge regarding sign & symptoms, diagnostic measures, and nursing management as P-value ‹ 0.05.

**Table (3):** Displays a comparison between nurses' practice in relation to maintaining a patent airway and Achieving an adequate breathing pattern on pre and post-test. As illustrated in the table, less than half of the nurses suction the airway with care pre oxygenated & briefly hyperventilated 100% oxygen (42.5%) on pre-test compared to 97.5% on the post-test. On other hand, all nurses have used open suction technique on pre and post-test (100%). Meanwhile, on the pre-test, more than one-third of them auscultate lung sounds every 8 hours and elevate the head of the bed (37.5% and 35% respectively) compared to post-test (75% and 77.5% respectively). Also, less than half of the studied sample monitors respiration & its irregularities, and record neurological observation (45% and 45% respectively) compared to 82.5% and 67.5% on post-test.

**Table (4):** Represents a comparison between nurses' practice in relation to optimizing cerebral tissue perfusion on pre & post-tests "proper position, & minimizing environmental stimuli". Concerning the proper position, it was revealed that the majority of nurses kept the head of patients in a neutral (midline) position and avoided extreme rotation of the neck on the pre-test (65% and 67.5%) compared to 92.5% and 90% on post-test. Moreover, on the pre-test, more than half of the studied sample elevated head of the bed (30- 45 degrees) and avoided extreme hip flexion (52.5% and 57.5% respectively) compared to 82.5% and 85% on post-test. Regarding minimizing environmental stimuli, the majority of studied nurses were spacing nursing activities, avoiding frequent arousal from sleep, and maintaining a calm atmosphere on post-test (92.5%, 62.5, and 80% respectively). For that reason, there were statistically significant differences before and after intervention.

**Table (5):** Depicts a comparison between nurses' practices as regard to maintaining negative fluid balance on pre, and post-test. It was revealed that the majority of nurses monitored urine osmolality, glycemic control and serum glucose 4 /6 hrs (70%, 67.5%, and 70% respectively). While approximately one-third of them assessed mucous membrane and administered IV fluid at the prescribed rate (35% and 32.5% respectively).

**Table (6):** Shows a comparison between nurses' practice in relation to the monitoring of potential complications on "pre & post-test, it was revealed that the majority of studied nurses assessed the level of consciousness, pupil changes, weakness of extremities & headache and used pain assessment scale on post-test compared to the pre-test. On the other hand, all the studied nurses (100%) assessed later indicators of increased ICP such as decreased pulse, respiration, and temperature. On the other hand, more than half of the studied sample monitored increased pulse pressure and projectile vomiting (52.5% and 52.5% respectively) compared to 82.5% and 80% on post-test.

**Table (7):** Displays comparison between total mean score of nurses' knowledge and practices concerning ICP on pre, and post-tests. On the post-test, it was shown that there was a significant increase in knowledge and practice.

## Discussion

Raised intracranial pressure is an abnormal condition with important nursing implications for children with the concomitant condition. As a result, caring for children with neurological problems is a tremendous task for the entire paediatric nursing staff, needing specialized and continuing care for ICP children. The causes of raised ICP are several. The major goal of treatment for these children is to avoid further brain injury. The treatment of these children is based on the principles of early stabilization and targeted management of elevated ICP **(Pedersen et al., 2020)**. The study was aimed to inspect the effects of educational nursing strategies on the management of increased intracranial pressure in children with neurological injury. There were statistically differences in nurses' mean knowledge of elevated intracranial pressure in children on pre and post-test.

The nurses in our study revealed that the total mean knowledge increased after implementation of educational nursing strategies rather than pre-test. Unsatisfactory nurses' knowledge about increased intracranial pressure pre-test may be traced back to the fact that the majority of nurses have only a diploma, while students are exposed to pediatric critical care nursing as part of their training, they are not adequately trained or competent to care for children in PICUs, in addition to a lack of training educational programs for staff nurses about increased intracranial pressure in children. Concerning enhancing nurses' knowledge about caring for children with raised intracranial pressure in the post-test, this demonstrates nurses' preparedness and interest to learn more and, as a result, enhance the care delivered to children in PICUs. This demonstrated the promising impact of the training program on nurses since it improved their knowledge and helped them reach the current study's goal. This

was in line with **Hussein (2018),** who stated that after completing an educational programme, the total score of knowledge improved. Also**, Oyesanya & Snedden, (2018)** indicated that there was a highly statistically significant difference in nurses' total knowledge scores for the nursing intervention of increasing intracranial pressure before and after the guidelines intervention. The current study found a statistically significant difference in all aspects of nurses' knowledge about children with elevated intracranial pressure pre-test and post-test. In this respect, **Hussein et al., (2017)** emphasized that PICU nurses must have a thorough understanding of brain content and physiology and how it varies as patients worsen or recover. Knowledge of at-risk patient demographics as well as the signs and symptoms of raised ICP is required for rapid detection and management of children with elevated ICP.

According to the researcher, nurses lack basic knowledge about the children with elevated ICP, and various training and teaching programs should be implemented. It is vital to have a thorough understanding of increased ICP since the results will influence judgments and nursing management of pediatric patients. Regarding the effect of nursing educational programs on nurses' practices, there were statistically significant differences were found between mean scores between pre and post intervention. This could be related to the establishment of a nursing educational programme. In addition to the content of the program, was created in response to nurse demands to learn more and improve their ability to care for children with increased intracranial pressure, as well as the training program's good impact on PICU nurses. In this context, **Bratton et al., (2017)** added that high control of ICP can result in positive neurological consequences. Nurses' practices were also affected by the fact that they were unaware of their responsibilities and that medical directions were unclear so, the nurses need training program. The current study found that the nurses in post-test performed significantly better than the pretest. According to the researcher, this could be linked to the nurses' increased self-confidence after completing the educational intervention, as a result of a higher level of knowledge and experience. This result is consistent with **Eldesouky, (2016)** who reported that enhanced nurses' knowledge leads to greater performance of nurses. Self-assurance contributes to the quality of service provided and ensures that professional development is maintained.

Airway management is a key component in various clinics in the pediatric intensive care unit. Maintaining patent airway is always the first priority, especially in cases like trauma, acute neurological decompensating, or cardiac arrest **Hill et al, (2018).** Regarding the maintaining of a patent airway & achieving an adequate breathing pattern, the present study clarified that the mean and standard deviation increased on post-test than pre-test. Furthermore, there were statistically significant variations between the pre- and post-test in terms of monitoring respiration and irregularities, monitoring pulse oximeters, and recording neurological observations. On other hand, In terms of monitoring PaCO2, there was no statistically significant variation between pre and post-test. In this context **Mendaro et al., (2019)** explain that hyperventilation must be carefully controlled, constant monitoring of Cerebral Perfusion Pressure (CPP) and PaCO2 is essential. CPP must be maintained at 60 mmHg. If not, the patient's condition can worsen **Geeraerts et al., (2018)** emphasize the importance of nurse empowerment and the adoption of care protocols that include interventions to control and regulate ICP so that therapy may be intervened quickly and effectively.

Regarding the effect of the nursing education program on nurses' practices, this study showed that nurses had inadequate practices in pre-nursing educational program regarding optimizing cerebral tissue perfusion through Proper position, & minimizing environmental stimuli. This is supported by **Abd El-Azim et al., (2019**) who study that the impact of self-learning package on nurses' performance about care of head injury children**,** this study showed that nurses had incompetent practices in pre-self-learning package implementation regarding maintaining adequate cerebral tissue perfusion through assessing neurological status. This clarifies the importance of educational programs to raise their awareness and improve their practice.

Furthermore, there were no statistically significant differences between the pre and post-test in terms of keeping the head in a neutral (midline) position, holding patients' heads during turning, and raising the head of the bed to 30 degrees allowing for gravity-assisted venous outflow from the brain. It is vital to remember that the child must not be hypovolemic and the pediatric nurse should raise the head of the bed to 30 degrees **(Wohlgemuth, 2016 & Geeraerts et al., 2018**). Moreover, a cervical collar is worn to keep the neck immobilized and prevent spinal cord injury. It's also employed to avoid any neck flexion, which could prevent venous outflow from the head and cause an increase intracranial pressure.

It is critical for the paediatric nurse to recognize the effects of the surroundings and external stimuli on the child's ICP and to devise strategies to reduce ICP elevations. Stress on the body and prolonged

sympathetic stimulation cause oxygen and nutrient demand to surpass supply, resulting in elevated ICP. The nursing care for a patient with an elevated ICP is calm and not hurried. Clustering nursing care or patient activities raises the patient's metabolism, CO2 generation, and induces cerebral artery dilatation, all of which raises ICP. The goal of nursing care is to reduce the patient's stimulation as well as their tension. This is accomplished by giving a darkened area, lowering noise levels, limiting visits, and reducing nursing activities like suctioning. Only perform patient tasks if they are absolutely necessary. Patients may even be medically paralyzed (e.g., Barbiturates) and intubated to reduce their metabolic requirements **(Maiese, 2019).** There were statistically significant differences in nurse practice between pre and post-test to maintain a calm atmosphere and avoid frequent arousal from sleep.

However, there were no statistically significant variations between pre- and post-test results when it came to clustering nursing activities. It is obvious that this item cannot be implemented if there is a shortage of nurses' number especially during the afternoon shift. The administrative policy should be developed to maintain a balance between the number of nurses and patients to enhance monitoring fluids and electrolytes is a subtle balance. Three percent NaCl or Mannitol is given intravenously to pull fluid into the vascular space for elimination. These medications require alert monitoring. Urine analysis tests display the child's fluid status via ADH production and monitoring for electrolyte imbalances is essential **(Gooley et al., 2016**). Hyperglycemia that persists after the initial presentation has been linked to poorer neurological results, therefore blood glucose levels should be closely monitored **(Chen & Liu, 2020**). Oral care is commonly performed by Pediatric Intensive Care Unit nurses on patients who have their intracranial pressure monitored. Despite the absence of evidence, this intervention may be withheld when the intracranial pressure is elevated or rises in response to oral care **(Pillai et al., 2018).** Concerning maintaining negative fluid balance "assessing fluid status **",** differences in pre- and post-test scores that are statistically significant regarding the assessment of mucous membrane, urine osmolality, IV fluid administered at the prescribed rate, oral hygiene, glycemic control, and monitor serum glucose 4/6 hrs. The pre and post-tests showed no statistically significant differences. Regarding skin turgor may be linked to the program's good impact on nurses' knowledge and practice, as well as the importance of their application.

As regards the neurological assessment, the current study showed a statistically significant difference between the level of nurses' practice on pre and post-test. It was found widely acknowledged that implementing a training program improved nurses' practices. In contrast to that **Mayday et al., 2016** there was found no statistically significant variation in the degree of nurses' practice regarding neurologic assessment before and after the recommendations were implemented. The frequency of neurological examinations varies depending on the severity of the disease, underlying condition of the child. It can range from 15 minutes to every four to eight hours. In this context **Souza & Papel, (2019)** emphasized the importance of educational program that provide safe nursing interventions and avoids any errors that can aggravate the neurological disease by raising ICP. Given the necessity for ongoing attention in the administration of interventions for their recovery, professionals must be trained to provide safe and skilled care to critically sick patients. **Elsayed, (2018)** discovered satisfactory nursing practices about head injury nursing care in the targeted PICU post-intervention, which supports the current study. Moreover, **Liu et al., (2020)** clarified the importance of sufficient nursing programs to improve children safety. Also, in this respect **Hopkins et al., (2018**) reported that Pediatric nurses should utilize clinical judgement to determine whether a higher frequency of neurological observations is essential, as well as whether the frequency of neurological observations should be raised. More neurological evaluations, which are within the scope of practice for pediatric nurses, are critical.

## Conclusion:

According to the current study's findings, implementing educational nursing strategies had a statistically significant positive influence on nurses' knowledge and practice, as evidenced by the acquired data.

## Recommendations:-

The following Recommendations are offered based on the study's findings:

1. Ongoing educational program for nurses caring for children with raised intracranial pressure should be developed on a regular basis in order to improve nurses' knowledge and practice in order to provide high-quality care
2. Creating and distributing a manual procedure book to all pediatric critical care nurses that covered the required standard approaches.
3. Developing a system of periodical nurses' evaluation to determine strategies for updating their knowledge and enhancing their practice.

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