Evaluating the Effect of a Neuro-protective Care Bundle for Neonatal Nurses on Rate of Seriousness of Intraventricular Hemorrhage among Preterm Infants

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Abstract

Background. Intraventricular hemorrhage (IVH) poses a significant risk for preterm infants in Neonatal Intensive Care Units (NICU). Globally, nurses in the NICUs may adopt various strategies and protocols to reduce the incidence of IVH in preterm infants and mitigate potential neurodevelopmental complications. **Aim.** To evaluate the effect of implementing a neuro-protective care bundle for neonatal nurses on rate of seriousness of IVH among preterm infants. **Design.** A quasi-experimental research design was utilized. **Setting.** This study was carried out at NICU of Mansoura University Children Hospital, Mansoura City, Egypt. **Subjects.** A convenience sample of nurses (n=50), as well as a purposive sample of preterm infants less than 33 weeks of gestation (n=85) were recruited from a tertiary level NICU of the previously mentioned settings. **Tools.** Data were collected by using three tools: 1) A structured questionnaire sheet to assess nurses' knowledge related to IVH and Neuro-protective care bundle. 2) Observational neuro-protective checklist. 3) Intraventricular hemorrhage rate of seriousness scale. **Results.** Post implementation of the study neuro-protective care bundle there were statistically significant differences in the nurse's knowledge and their performance between pre and immediate post as well as between pre and post 3 months after implementation of neuro-protective care bundle. Moreover, there is a statistically significant difference between the rate of seriousness of IVH before and after implementation of neuro-protective care bundle. **Conclusion and recommendation.** Implementation and methodical application of an IVH care bundle that encompasses postnatal measures surrounding the early birth days of preterm babies can positively affect their neurological outcome by controlling rates of seriousness of IVH. These measures require training and education of bedside nurses on behalf of the entire NICU staff to be thoroughly implemented.

Keywords: Neuro-protective Care Bundle, Intraventricular hemorrhage, Preterm infants, Neonatal Nurses, Rate of Seriousness

Introduction

Intraventricular Hemorrhage (IVH) in preterm infants refers to bleeding that occurs within the brain's ventricular system. This condition is particularly prevalent in premature infants and is commonly associated with the fragility of blood vessels in the germinal matrix, a highly vascularized area in the developing brain and to the fluctuation in the cerebral blood flow. The severity of IVH is inversely linked to gestational age and birth weight, making extremely premature infants more susceptible. IVH often initiates in the germinal matrix and can have significant implications for the neurological development of preterm infants **(Parodi, et al., 2020)**.

Intraventricular hemorrhage is a major neurological complication of prematurity. Germinal matrix hemorrhage and intraventricular hemorrhage (GMH-IVH) remain important causes of brain injury in preterm infants. The negative impact of GMH-IVH on neurodevelopmental outcome is due not only to the direct consequences of GMH-IVH, but also to associated lesions including post-hemorrhagic ventricular dilatation and white matter injury **(Murthy, et al., 2020).**

Intraventricular hemorrhage is characterized by bleeding in or around the brain's ventricles, primarily affecting premature infants, especially those born over 10 weeks early. The highest risk for IVH is observed in infants born before 32 weeks of gestation or weighing less than 1500 grams at birth, with an incidence ranging from 20% to 25%. This bleeding exerts pressure on brain nerve cells, potentially causing damage. Severe damage may lead to brain injury, posing a long-term risk of neurocognitive damage. Several studies emphasize the enduring consequences of severe IVH on neurodevelopment. Severe IVH has been linked to persistent mortality and morbidity, particularly in preterm-born infants. The condition can cause lifelong neurocognitive impairments, affecting various domains such as motor skills, cognition, and sensory processing **(Tsao, 2023).**

Cranial ultrasound scans are commonly conducted to identify IVH. These images are utilized to categorize IVH into different grades: grade I, where the hemorrhage is confined to the subependymal region; grade II, characterized by blood presence in the ventricles without ventricular distension; and grade III, involving enlarged ventricles due to distention. The classic grade IV IVH results from white matter infarction rather than the extension of the hemorrhage into parenchyma **(Volpe, 2018).**

Neuroprotection aims to improve neurodevelopmental outcomes through the implementation of evidence-based interventions beginning from prenatal, perinatal, and postnatal through the first three days of life. Various protective measures are implemented to mitigate the risk as administering antenatal steroids has been shown to lower the risk of IVH in preterm infants. Additionally, efforts to prevent preterm delivery play a crucial role and careful monitoring and intervention strategies aim to prolong gestation and reduce the likelihood of IVH. Implementation of IVH care bundles that include perinatal measures has a positive impact on neurological outcomes. These bundles encompass a set of interventions designed to decrease the incidence and severity of IVH in preterm infants **(Macho, 2018; Bijl-Marcus, 2020)**.

These measures include reducing pain and stress, ensuring proper newborn positioning, and modifying the NICU environment. Pain and stress can hinder venous return, leading to increased cerebral blood volume (CBV). Therefore, recommendations involve practices like swaddling, establishing boundaries, providing preemie hugs, minimizing stimulation, and creating a quiet and dark environment. Recent germinal matrix-IVH prevention bundles in various institutions now emphasize midline head positioning due to reported instances of increased intracranial pressure and CBV after head rotation. This increase is attributed to the obstruction of the homolateral jugular veins, which has been associated with a higher predisposition to IVH **(Romantsik, et al., 2020).**

Significance of the study

Intraventricular hemorrhage is a significant neurological complication in preterm infants, affecting morbidity and mortality. Intraventricular hemorrhage primarily arises from unstable hemodynamics and prematurity, with its highest occurrence within the initial five days of a preterm infant's life. Given the limited nursing care and therapeutic options post-IVH diagnosis, emphasis on prevention is paramount. Implementing bundled protective measures within the first 72 hours after birth is crucial for nurses to play a pivotal role in mitigating IVH risk **(Daigneault et al., 2020).**

Neonatal nurses play a crucial role in the prevention and care of preterm infants at risk of IVH. Their responsibilities encompass a range of practices aimed at safeguarding the delicate health of these vulnerable infants: close clinical monitoring of preterm infants is essential to identify early signs of distress or complications. Neonatal nurses are adept at monitoring vital signs, neurological status, and response to interventions, contributing to the early detection and management of IVH. Nurses actively participate in the implementation of preterm infants' care bundles, encompassing a set of interventions designed to prevent IVH. These bundles often include patient positioning, nursing care protocols, and medical interventions, aiming to collectively reduce the incidence of IVH in preterm infants. The expertise and dedication of neonatal nurses are

fundamental in creating a nurturing environment that promotes the well-being of preterm infants and mitigates the risk of IVH **(Garfinkle & Miller, 2020; Al-Haddad., 2022)**. Thus, the current study investigated nurses' knowledge and performance at NICU and evaluated the effect of implementation a neuro-protective care bundle on rate of seriousness of IVH in preterm infants.

Aim of the study

To evaluate the effect of implementing a neuro-protective care bundle for neonatal nurses on rate of seriousness of intraventricular hemorrhage among preterm infants.

This aim can be achieved through:

1. Evaluating neonatal nurses' knowledge and performance about neuro-protective care bundle before the implementation.
2. Designing and implementing a neuro-protective care bundle to be applied in the first 72 hours of preterm infants' life.
3. Investigate neonatal nurses' knowledge and performance related neuro-protective care bundle post the implementation.
4. Assess intraventricular hemorrhage rate of seriousness post implementation of neuro- protective care bundle.

Research Hypothesis

H_1. Implementation of intraventricular hemorrhage neuro-protective care bundle may show a significant improvement of neonatal nurses' knowledge and performance.

H_2. Implementation of intraventricular hemorrhage neuro-protective care bundle may inhibit rate of seriousness of IVH in the first 72 hours of preterm infants' life.

Subjects and Method

Research design: A quasi - experimental research design was utilized in this study.

Setting: This study was carried out at Neonatal Intensive Care Unit at Mansoura University Children Hospital (MUCH), Mansoura City. The unit consisted of 2 separate rooms; each room consisted of 6 incubators. The nurse to preterm infant ratio in the morning shift was 1:2 (1 nurse to 2 preterm infants) and sometimes 1:1 while; in the afternoon and night shifts was 1:3. The setting is well equipped with mechanical ventilators, cardiac monitors, weight scale and ultrasonography machine. The study continued for 6 months extending from the 1st of March 2023 to the end of August 2023.

Subjects: The study sample included:

1) A convenient sample of neonatal nurses working in Level III intensive care units, totaling 50 participants. The nurses were selected based on their availability, affiliation with the mentioned setting, and their role in caring for preterm infants, without considering their age, qualification, or years of experience.
2) A purposive sample of 85 preterm infants was intentionally chosen based on data from literature **(El Tatawy et al., 2022)**, considering level of significance of 5%, and power of study of 80%, the sample size can be calculated using the following formula:

$$n = \frac{2(Z\alpha/2 + Z\beta)^2 \times p\,(1-p)}{(d)^2}$$

where, p = pooled proportion obtained from previous study; d = expected difference in proportion of events; $Z_{\alpha/2}$ =1.96 (for 5% level of significance) and Z_{β} = 0.84 (for 80% power of study). Therefore,

$$n = \frac{2(1.96 + 0.27)^2 \times 0.1\,(1-0.27)}{(0.19)^2} = 85$$

Accordingly, the sample size required is 85 preterm infants, they were intentionally chosen based on data from literature predetermined inclusion criteria. The selection criteria for preterm infants included in the study were as follows:

- Preterm infants at the first day after birth

- Gestational age 28-33 weeks
- Weight from 750 to 2000 grams
- Both genders

Exclusion criteria encompass preterm infants admitted with cerebral abnormalities or surgical interventions involving the brain or neck.

Tools of data collection

Tool 1: A structured sheet to assess nurses' knowledge related to all aspects of IVH Neuro-Protective Care Bundle in tertiary III level of NICU.

This tool was developed by researchers after reviewing the related literature **(Gross, et al., 2021; El Amouri, 2021** & **Kolnik, et al., 2023**). Questions were in the form of multiple-choice questions. This tool was used pre, post and follow up after 3 months of the bundle implementation. The answers were checked with model answer. It included three parts as the following:

Part I: Characteristics regarding the surveyed nurses, including age, educational level, duration of experience at the neonatal intensive care unit.

Part II: Characteristics of the examined preterm infants, encompassing gender, gestational age, and weight.

Part III: Assessment of the nurses' knowledge regarding the Intraventricular Hemorrhage Neuro-Protective Care Bundle (NPCB), comprising comprehension of IVH definition and pathophysiology, awareness of adverse outcomes associated with IVH, understanding of the primary components of the neuro-protective care bundle, and identification of infants at risk for IVH development (pre/post-test).

Scoring system

Nurses' knowledge is assessed through an 11-item questionnaire, with each correct answer earning one mark and incorrect or omitted answers receiving zero marks. The total score ranges from 0 to 11, determining the nurses' overall knowledge level.

The knowledge levels are categorized as follows:

- Poor: < 50% (from 0 to less than 5.5)
- Average: From 50% to 75% (from 5.5 to 8.25)
- Good: ≥ 75% (more than 8.25)

Tool 2: Observational Neuro-protective Care Bundle Checklist (Pre/Post-test)

It was adapted from **Chiriboga, (2019)** to assess nurse's performance related to prevention of IVH pre, post and follow up after 3 months of IVH neuro-protection care bundle implementation. It is composed of the following items: midline positioning, minimal handling, elevating the head of the bed 15-30 degrees, avoid prone positioning, no bath given, keep natural thermal regulation between 36.5-37.5, non-pharmacologic measures utilized to minimize pain/stress: swaddling, maintaining boundaries, and shielding eyes from light.

Scoring system: Scores were estimated as zero awarded for not done and one mark awarded for done on every day of the three days of observation. Total performance 9 items = 27 marks. Performance was categorized into two levels:

Incompetent: < 75 % (from 0 to 20.25)

Competent: ≥75% (more than 20.25)

Tool 3: Intraventricular Hemorrhage Rate of Seriousness Scale (post-test):

Intraventricular hemorrhage rate of seriousness scale using cranial ultrasonography is routinely applied by the NICU physicians for all admitted preterm infants at the third and seventh day after birth at the previously mentioned study setting to evaluate preterm infant's status as regard to development of IVH. The rate of seriousness scale for IVH was established by **Volpe et al. in 2017**. This scale, based on cranial ultrasonography findings, serves to assess the rate of seriousness of IVH. Utilized for evaluating the rate of seriousness of IVH, it involves cranial ultrasound examinations conducted on the third and seventh days of a infant's life. The IVH grades, as per the IVH rate of seriousness scale, are delineated as follows:

- Grade 1: Blood fills less than 10% of the ventricle.
- Grade 2: Blood fills between 10% and 50% of the ventricle.
- Grade 3: Blood fills more than 50% of the ventricle.
- Grade 4: Periventricular infarction occurs.

This rate of seriousness system facilitates the measurement of IVH rate of seriousness before and after the implementation of a neuro-protective care bundle protocol, aiding in monitoring the effectiveness of interventions.

Validity

The questionnaire underwent content validity assessment by three pediatric nursing experts at faculty of nursing – Mansoura University. This evaluation aimed to test and judge content validity, clarity, and comprehensiveness of the study instruments. Modifications comments were taken into consideration based on the feedback provided by the experts, which was mainly in the form of rephrasing statements to ensure the content's appropriateness.

Reliability of the tools

The internal consistency of the instruments was evaluated, revealing Cronbach's alpha values of 0.884 for assessing nurses' knowledge of IVH, 0.896 for evaluating nurses' performance and 0.799 for intraventricular hemorrhage rate of seriousness scale. These assessments were conducted using the Statistical Package for Social Science (SPSS) version 21.

Pilot study

A pilot study was carried out on 10% of the participants (10 nurses and 9 preterm infants) to evaluate feasibility, time, cost, adverse events, and improve upon the study design prior to performance of a full-scale research project. Any necessary modifications were made accordingly. The subjects of the pilot study were excluded from the study total sample to avoid data contamination.

Fieldwork

- **Data Collection:**

The data collection spanned six months, commencing from March 1st and concluding at the end of August 2023. Researcher initiated the process by introducing themselves to the nurses, providing a brief overview of the study's objectives and nature. The researcher actively participated in the study setting three days per week, covering three shifts at 9:00 am, 2:00 pm, and 7:00 pm.

- **Study Framework:**

The study was structured into five distinct phases.

Phase 1. Initial Data Collection (Assessment Phase):

- Evaluate nurses' knowledge and performance related to the implementation of the neuro-protective care bundle **(Tool 1 & 2)**.

- **Individual Interviews:** Prior to neuro-protective care bundle sessions, each nurse underwent individual interviews. This aimed to establish a baseline, and data were collected using study Tool (I) Part (I).

- **Knowledge Assessment:** Tool (1) Part (III) was employed to assess nurses' understanding of the neuro-protective care bundle.

- **Performance Assessment:** Nurses' practical implementation of the neuro-protective care bundle on preterm infants was evaluated using Tool (2).

- **Preterm Infants Assessment:** Post-implementation, preterm infants were assessed using the Preterm infant's IVH Assessment tool as a post-test to measure the effectiveness of the bundle.

Phase 2. Establishing Goals and Objectives

- Formulating goals, priorities, and expected outcomes based on the assessment phase findings to enhance outcomes for both nurses and preterm infants.

Phase 3. Designing Neuro-Protective Care Bundle Sessions for Nurses

- **Approach:** Drawing from existing evidence-based literature, identifying essential knowledge and performance,

determining optimal timing for each session, and selecting an effective teaching strategy.

- **Implementation:** Two planned sessions on the Neuro-Protective Care Bundle **Theoretical Session:** The initial session focused on elucidating the definition of IVH and the Neuro-Protective Care Bundle. It delved into understanding the components, the pathophysiology of IVH, its significance, identification of negative outcomes for preterm infants, recognizing preterm infants at risk, and elucidating the advantages of the IVH Care Bundle for both preterm infants and nurses.

Training Session: The subsequent session involved the practical training of the participating nurses in the implementation of the Neuro-Protective Care Bundle specifically designed for preterm infants. It is composed of the following items: midline positioning, minimal handling, measures to keep natural thermal regulation between 36.5-37.5, non-pharmacologic measures utilized to minimize pain/stress: swaddling, maintaining boundaries, and shielding eyes from light.

Phase 4. Executing NPCB Sessions for Nurses

- Neuro-protective care bundle sessions were administered to a cohort of 50 nurses, with each nurse participating in two sessions per week.

- The sessions comprised both theoretical and practical components, lasting approximately 60 minutes each. This time was utilized for thorough discussions and clarifications of NPCB elements, with a keen focus on addressing any queries from the nurses.

- The enrolled nurses were distributed among 5 groups, each consisting of 10 nurses. Throughout the sessions, the researcher employed various teaching techniques, including questioning, group discussions, brainstorming, demonstrations, and re-demonstrations.

- Various educational aids, including handout guidelines and PowerPoint presentations on the Neuro-Protective Care Bundle (NPCB), were distributed to each nurse post-assessment (during the inaugural session). This aimed to capture their attention, motivate them, and facilitate content review as needed.

- The researcher conducted pre- and post-implementation observations of nurses' performance during morning, afternoon, and evening shifts using Tool (II).

- The observation sessions commenced at 9 am for the morning shift, 2 pm for the afternoon shift, and 7 pm for the evening shift, spanning three days.

- To evaluate neonatal outcomes, the Preterm Infants' Assessment Tool, parts II and III, were utilized on 85 preterm infants before and after NPCB implementation.

- The researcher communicated information in a concise, clear, and straightforward manner during the sessions.

- At the conclusion of each session, a brief and summarized overview was provided.

Phase 5. Evaluation of Neuro-Protective Care Bundle (NPCB) Effectiveness:

- Following the implementation of NPCB sessions, each nurse underwent an interview, utilizing the same pre-test format, to assess knowledge and performance.

- Neonatal outcomes were evaluated post-NPCB implementation using the pre-test format and a neonatal IVH assessment post-test tool.

- Comparative analysis of nurses' pre and post-test results aimed to gauge the impact of NPCB sessions on their knowledge and performance during implementation.

- Similarly, the examination of preterm infants' pre and post-test results aimed to determine the impact of NPCB sessions on nurses' performance levels and, consequently, improvements in neonatal outcomes.

Ethical Considerations:

Ethical approval was secured from the Research Ethics Committee of the Faculty of Nursing, Mansoura University, with reference number p.0413, allowing the initiation of the study. Additionally, approval was obtained from the head of Mansoura University Children

Hospital (MUCH) to conduct the research. Prior to their involvement, each participating nurse provided informed oral consent, comprehensively briefed on the study's objectives, benefits, risks, and procedures. Ensuring utmost confidentiality, data were handled exclusively for research purposes. Nurses were explicitly notified that their participation was voluntary, retaining the right to withdraw at any point without incurring any obligations.

Statistical Analysis:

The data underwent rigorous statistical analysis employing the most contemporary and reliable methods. Collected data were coded, categorized, and statistically processed, presenting results in various formats, including numbers, percentages, tables, and figures as required. SPSS for Windows was utilized for all statistical analyses. Continuous data, exhibiting normal distribution, were expressed as mean ± standard deviation (SD), while categorical data were represented in numerical and percentage formats. Analytical techniques included the use of Repeated Measure ANOVA for three paired groups, One-way Analysis of Variance (ANOVA) for comparisons among more than two variables with continuous data, Chi-square test for categorical data comparisons, and Pearson Correlation Coefficient test for assessing correlations between two continuous variables. Additionally, the internal consistency of questionnaires used in the study underwent a reliability test. Statistical significance was established at $p<0.05$.

Results

Table (1) illustrates that 32% of the studied nurses aged from 30 - < 40 years old with the mean age of 31.42 (5.25) years. As regards nurses' educational level, it was noticed that 56% had nursing bachelor's and 44% of them had from five years of experience to less than 10 years. Additionally, the current study reported that 86% of the studied nurses not participated previously in any training about neuro-protective care bundle.

Table (2) revealed that 64.7% & 69.4 of the studied preterm infants respectively were boys and had from 28 - < 30 weeks of gestational age. Regarding their weight the current study demonstrates that 54.1% of them were weighing from 1000g < 1500g with a mean weight of 1372.74 (172.78) g.

Table (3) indicates notable statistical distinctions in nurses' knowledge levels. These differences were observed between the pre-implementation phase and both the immediate post-implementation and the post-implementation assessments conducted three months later after the implementation of the neuro-protective care bundle ($p=0.000^{*}$).

There were highly statistically significant among nurses' performance related to neuro-protective care bundle pre, immediate and post 3 months after neuro-protective care bundle implementation with P value 0.000* as clarified at **Table (4).**

Figure (1) illustrated that there was statistically significant difference between rate of seriousness of intraventricular hemorrhage before, at the third day and at the seventh day after implementation of neuroprotective care bundle.

The relation between the preterm infants' characteristics and rate of seriousness of intraventricular hemorrhage are detailed in **Table (5)**. Pre implementation of the IVH protection care bundle there was a significant relationship (P=0.003*) between infants' gestational age and the rate of seriousness of grade 1 and 2 IVH. In addition, there was a significant relationship between infants' weight and occurrence of IVH post implementation of IVH protection care bundle (P=0.007*).

Table (6) illustrates the correlation between nurses' personal characteristics and their overall knowledge scores concerning the neuro-protective care bundle before, immediately after, and three months post-implementation. Initially, there was a notable association between nurses' age and total knowledge score (P=0.002*). Subsequently, following the implementation, both immediately and three months later, a significant correlation emerged between educational level and total knowledge score (P=0.000* for each).

The relationship between characteristics of the surveyed nurses and their total performance

scores related neuro-protective care bundle pre, immediate and 3 months post NPCB implementation are portrayed in **Table (7)**. The table shows that there are no significant statistical differences in relation to nurses' age and years of experience pre, immediate and 3 months post implementation. While the educational level was significantly different immediately after the care bundle implementation (P=0.006*).

Upon reviewing **Table (8),** it becomes evident that there is a positive correlation between total knowledge and total performance score regarding neuro- protective care bundle immediately after implementation of the care bundle (0.001*).

Table (1). Characteristics of the Studied Neonatal Nurses N = (50)

Items	N = (50)	(%)
Age		
From 20 to less than 25	6	12
From 25 to less than 30	12	24
From 30 to less than 35	16	32
From 35 to less than 40	15	30
40 and more	1	2
$\bar{X}$ **(SD)**	**31.42(5.25)**	
Educational level		
Diplome (nursing school)	13	26
Technical nursing institute	9	18
Bachelor's degree (BSc)	28	56
Years of experience		
1 to less 5	11	22
5 to less than 10	22	44
10 to less than 15	8	16
15 to less than 20	9	18
$\bar{X}$ **(SD)**	**8.24(5.22)**	
Previous Training about neuro-protective care bundle		
Yes	7	14
No	43	86

Table (2). Characteristics of the Studied Preterm Infants (N=85)

Items	N = (85)	(%)
Gender		
Male	55	64.7
Female	30	35.3
Gestational age (week)		
Less than 28	2	2.4
From 28 to 30	59	69.4
More than 30 to 33	24	28.2
$\bar{X}$ **(SD)**	**30.6 (1.01)**	
Weight (gram)		
less than 1000 g	1	1.2
from 1000 to less than 1500 g	46	54.1
from 1500 to 2000g	38	44.7
$\bar{X}$ **(SD)**	**1372.74 (172.78)**	

Table (3). Neonatal Nurses' Level of Knowledge regarding Neuroprotective Care Bundles Pre, Immediate and post 3 Months of Neuroprotective Care Bundle Implementation.

Knowledge	Test time N = 50						Test of significance	P value*
	Pre		Immediate		post 3 months			
	N	%	N	%	N	%		
Intraventricular Hemorrhage								
Definition of IVH	7	14	37	74	35	70		
Pathophysiology of IVH	5	10	37	74	37	74		
Negative outcomes of IVH on preterm infants	9	18	39	78	38	76		
Main component of neuro-protective care bundle								
Importance of neuro-protective care bundle	9	18	39	78	40	80		
Midline Positioning	4	8	37	74	36	72		
Minimal Handling	7	17	38	76	35	70		
Swaddling	3	6	34	68	35	70		
maintaining boundaries	9	18	44	88	44	88		
shielding eyes from light	6	12	30	60	32	64	**X2=103.155**	
Thermoregulation	2	4	39	78	42	84		
Preterm infants at risk for developing IVH.	11	22	39	78	39	78		
Total knowledge (11 marks)								
Good	1	2	35	70	34	68	**F=69.695**	
Average	8	16	2	4	9	18		**0.000***
Poor	41	82	13	26	7	14		
$\overline{X}$ (SD)	3.96(1.86)		8.76(3.44)		8.72(2.27)			**0.000***

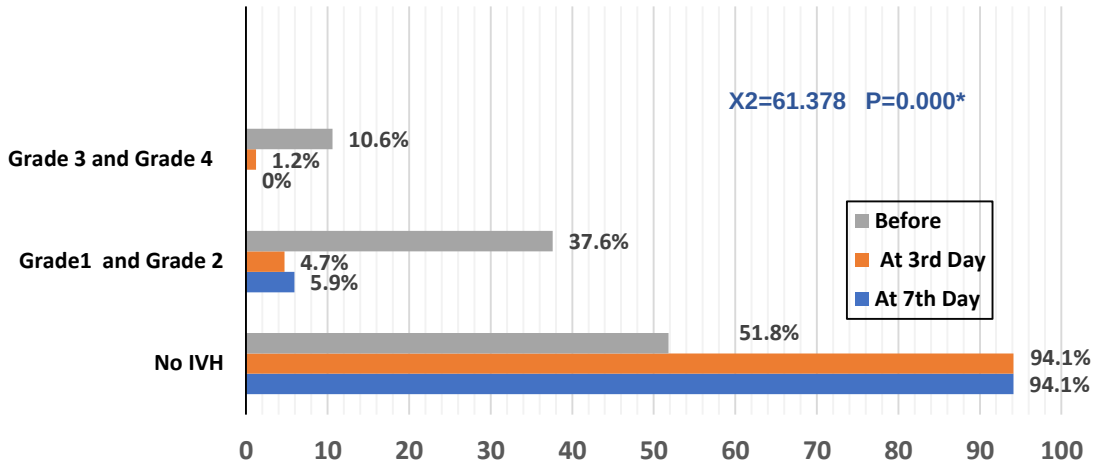
X2 : Chi square **F** : Repeated measure ANOVA P (significance)*

Table (4). Neonatal Nurses' Performance related to Neuroprotective Care Bundle Pre, Immediate and Post 3 Months of Neuroprotective Care Bundle Implementation.

Items	Pre	Immediate	post 3 months	Test of significance	P value
	N (%)	N (%)	N (%)		
Midline head positioning					
Not performed	27(54)	2(4)	0		
Preformed only in the first day	23(46)	6(12)	3(6)		
Performed at the first & second day	0	9(8)	1(2)		
Performed in the three days	0	33(66)	46(92)		
No prone positioning					
Not performed	20(40)	5 (10)	2(4)		
Preformed only in the first day	30(60)	6 (12)	1(2)		
Performed at the first & second day	0	3(6)	1(2)		
Performed in the three days	0	36(72)	46(92)		
Elevating the head of the bed 15-30 degrees	26(52)	6(12)	0		
Not performed	24(48)	1(2)	2(4)		
Preformed only in the first day	0	1(2)	4(8)		
Performed at the first & second day	0	42(84)	44(88)		
Performed in the three days					
Minimal handling					
Not performed	12(24)	0	0		
Preformed only in the first day	38(76)	10(20)	1(2)		
Performed at the first & second day	0	3(6)	12(24)		
Performed in the three days	0	37(74)	37(74)		
No bath given				X2=102.98	**0.000***
Not performed	15(30)	4(8)	3(6)		
Preformed only in the first day	35(70)	8(16)	1(2)		
Performed at the first & second day	0	0	8(16)		
Performed in the three days	0	38(76)	38(76)		
Natural thermal regulation between 36.5-37.5	12(24)	0	0		
Not performed	24(48)	6(12)	0		
Preformed only in the first day	1(2)	3(6)	4(8)		
Performed at the first & second day	13(26)	41(82)	46(92)		
Performed in the three days					
Swaddling					
Not performed	34(68)	2(4)	1(2)		
Preformed only in the first day	16(32)	4(8)	2(4)		
Performed at the first & second day	0	1(2)	3(6)		
Performed in the three days	0	43(86)	44(88)		
Maintaining boundaries					
Not performed	9(18)	3(6)	2(4)		
Preformed only in the first day	15(30)	8(16)	2(4)		
Performed at the first & second day	1(2)	2(4)	9(18)		
Performed in the three days	25(50)	37(74)	37(74)		
Shielding eyes from light					
Not performed	42(84)	3(6)	0		
Preformed only in the first day	8(16)	4(8)	3(6)		
Performed at the first & second day	0	11(22)	1(2)		
Performed in the three days	0	32(64)	46(92)		
Total performance score (27 marks)					
Incompetent	48(96)	9(18)	2(4)		
Competent	2(4)	41(82)	48(96)		
$\overline{X}$(SD)	6.89(1.98)	22.94(3.02)	25(4.47)	F=439.459	**0.000***

X2: Chi square **F:** Repeated measure ANOVA P (significance)*

Figure (1). Rate of Seriousness of Intraventricular Hemorrhage Before, at Third and Seventh day after Implementing Neuro-protective Care Bundle



X2: Chi square P (significance)*

Table (5). Relation between the Preterm Infants' Characteristic and Rate of Seriousness of Intra Ventricular Hemorrhage

Time	**Pre**			**At 3rd Day**			**At 7th Day**	
Items	**No IVH N (%)**	**Grade 1 and Grade2 N (%)**	**Grade 3 and Grade 4 N (%)**	**No IVH N (%)**	**Grade 1 and Grade2 N (%)**	**Grade 3 and Grade 4 N (%)**	**No IVH N (%)**	**Grade 1 and Grade 2 N (%)**
Gender								
Male	25(29.4)	24(28.2)	6(7.1)	51(60)	4(4.7)	0	53(62.4)	2(2.4)
Female	19(22.4)	8(9.4)	3(3.5)	29(34.1)	0	1(1.2)	27(31.8)	3(3.5)
Test of significance	**X2=2.70 P=0.269**			**MC=4.05 P=0.109**			**FC=1.42 P=0.233**	
Gestational age								
Less than 28 weeks	1(1.2)	0	1(1.2)	2(2.4)	0	0	2(2.4)	0
From 28 to 30 weeks	29(34.1)	22(25.9)	8(9.4)	44(51.8)	2(2.4)	1(1.2)	44(51.8)	3(3.5)
More than 30 weeks	14(16.5)	10(11.8)	0	34(40)	2(2.4)	0	34(40)	2(2.4)
Test of significance	**MC=19.99 P=0.003***			**MC=0.99 P=1.000**			**MC=0.15 P=1.000**	
Weight								
less than 1000 g	0	1(1.2)	0	1(1.2)	0	0	0	1(1.2)
from 1000 to less than 1500 g	20(23.5)	21(24.7)	5(5.9)	44(51.8)	2(2.4)	0	42(49.4)	4(4.7)
from 1500 to 2000g	24(28.2)	10(11.8)	4(4.7)	35(41.2)	2(2.4)	1(1.2)	38(44.7)	0
Test of significance	**MC=5.3 P=0.235**			**MC=1.35 P=0.808**			**MC=19.03 P=0.007***	

X2 : Chi square **Mc** :Montecarlo **P** (significance)*

Table (6). Relationship between Characteristics of neonatal Nurses and their Total Knowledge Score related Neuroprotective Care Bundle Pre, Immediate and Post 3 Months of Neuroprotective Care Bundle Implementation.

Characteristics	Total knowledge		
	Pre Mean (SD)	Immediate Mean (SD)	Post 3 months Mean (SD)
Age			
From 20 to less than 25	3.67(1.03)	5.82(4.27)	7.33(2.94)
From 25 to less than 30	4.75(2.01)	9.75(2.63)	9.5(1.09)
From 30 to less than 35	3.81(1.80)	8.8(3.82)	8.38(2.7)
From 35 to less than 40	3.2(1.15)	8.55(3.54)	8.93(2.12)
40 and more	10(-)	10(-)	10(-)
Significance	**F=5.17 (P=0.002*)**	**F=0.887 (P=0.480)**	**F=1.133 (P=0.353)**
Level of education			
Diploma (nursing school)	3.54(1.39)	3.23(1.36)	5.46(1.5)
Technical nursing institute	3(1.41)	11(0)	9.67(1.58)
Bachelor's degree (BSc)	4.46(2.05)	10.61(0.88)	9.93(0.81)
Significance	**F=2.737 (P=0.075)**	**F=294.19(P=0.000*)**	**F=67.514(P=0.000*)**
Years of experience			
1 to less 5	3.91(1.81)	8.55(4.01)	8.45(2.46)
5 to less than 10	4.55(1.63)	8.36(3.76)	8.68(2.46)
10 to less than 15	3.13(1.25)	9.25(3.25)	8.38(2.26)
15 to less than 20	3.33(2.6)	9.56(2.13)	9.44(1.67)
Significance	**F=1.669(P=0.187)**	**F=0.312(P=0.817)**	**F=0.405(P=0.750)**

F: One way ANOVA -: Not applicable * Significant (p< 0.05)

Table (7). Relationship between Characteristics of Nurses and their Total Performance Score related Neuroprotective Care Bundle Pre, Immediate and Post 3 Months of Neuro-protective Care Bundle Implementation.

Characteristics	Total Performance		
	Before Mean (SD)	Immediate Mean (SD)	After 3 months Mean (SD)
Age			
From 20 to less than 25	6.33(2.25)	22.33(3.93)	24.83(0.75)
From 25 to less than 30	7.33(1.97)	24.25(1.82)	26.67(8.79)
From 30 to less than 35	7.12(1.86)	23.13(2.78)	25.25(1.65)
From 35 to less than 40	6.8(1.86)	22.6(2.97)	23.87(1.64)
40 and more	8(-)	23(-)	24(-)
Significance	**F=0.391 (P=0.814)**	**F=0.736 (P=0.572)**	**F=0.655 (P=0.627)**
Level of education			
Diploma (nursing school)	7.15(1.77)	21.31(2.59)	24.08(1.55)
Technical nursing institute	7.22(2.49)	24.89(1.69)	25.44(1.88)
Bachelor's degree (BSc)	6.86(1.78)	23.43(2.71)	25.46(5.81)
Significance	**F=0.180 (P=0.836)**	**F=5.710(P=0.006*)**	**F=0.446(P=0.643)**
Years of experience			
1 to less 5	7.09(2.51)	23.18(3.28)	24.82(1.66)
5 to less than 10	7.05(1.36)	23.14(2.9)	25.82(6.46)
10 to less than 15	7.25(2.55)	22.38(2.92)	25.38(1.69)
15 to less than 20	6.56(1.74)	23.78(1.72)	23.44(1.81)
Significance	**F=0.216(P=0.885)**	**F=0.349(P=0.790)**	**F=0.606(P=0.615)**

F: One way ANOVA -: Not applicable * Significant (p< 0.05)

Table (8). Correlation between Total Knowledge and Total Performance Score regarding Neuro-protective Care Bundle Pre, Immediate and Post 3 Months of Neuro-protective Care Bundle Implementation

Predictor	Total knowledge score					
	Pre		Immediate post		post 3 months	
	Rs	P	Rs	P	Rs	P
Total performance score	-0.006	0.968	0.446	**0.001***	**0.215**	**0.133**

Rs: for Pearson correlation * Significant (p< 0.05)

Discussion

Intraventricular hemorrhage (IVH) represents a significant complication in preterm infants, presenting ongoing challenges in Neonatal Intensive Care Units (NICUs) globally **(Yeo, et al., 2020).** The successful implementation of neuroprotective care bundle measures necessitates NICU staff possessing the requisite knowledge and skills, along with collaboration among the entire healthcare team. Neuroprotective care bundle interventions aim to mitigate potential adverse effects of the NICU environment on both immediate and long-term outcomes for preterm infants. Despite evidence supporting short and long-term benefits of neuroprotective care bundles, there remains a crucial need for effective training programs to standardize these strategies among all NICU nurses **(Johnson & Marlow, 2017; Macho, 2018)**. Therefore, the current study aimed to evaluate the effect of implementing a neuro-protective care bundle for neonatal nurses on rate of seriousness of IVH among preterm infants.

The study provided demographic insights into the profile of the nurses under examination. The mean age of the participants was found to be 31.42 years with a standard deviation of 5.25. A significant portion of the nurses held a bachelor's degree in nursing, constituting more than half of the studied group. Furthermore, it was observed that nearly half of the participants had professional experience ranging from five to less than ten years. The researchers attributed these results to the fact that the age of the nurses aligned with the typical age range of professionals caring for children in critical situations, accompanied by similar work experience. Moreover, a significant number of them possessed a bachelor's degree in nursing, a qualification deemed essential for handling this crucial patient demographic. These observations are consistent with findings from various other studies (**Macho, 2018; El Amouri, et al., 2021)**

The recent study reveals key characteristics of the investigated preterm infants. Notably, over two-thirds of the preterm infants under scrutiny were male. This result is matched with **Benlamri, et al., (2022)** in their study about "Neuroprotection care bundle implementation is associated with improved long-term neurodevelopmental outcomes in extremely preterm infants" as they found that IVH is a critical concern in preterm infants, particularly affecting males. Studies indicate that more than two-thirds of preterm infants experiencing IVH are male. Furthermore, a substantial proportion of these preterm infants were within the gestational age range of 28 to less than 30 weeks. In terms of weight, most of them weighed between 1000g and less than 1500g. These particular characteristics were intentionally selected because they are associated with a heightened vulnerability to IVH owing to their specific age and weight parameters, which carry a greater risk for this condition. This was confirmed by **Yeo, et al., (2020)**, who stated that early gestational age and low birth weight increase the risk of IVH in preterm infants. These findings are consistent with findings from various other studies (**Gross, et al., 2021; Kolnik, et al., 2023).**

Most nurses in the present study initially demonstrated poor knowledge and incompetent performance regarding protection of preterm infants from IVH before the implementation of the neuro-protective care bundle (NPCB). However, a statistically significant enhancement in both knowledge and performance was observed immediately and six months post NPCB implementation. The initial deficiencies in knowledge and performance were attributed

to the lack of written policies regarding the care of preterm infants and high-risk preterm infants, time constraints for nurses, an inadequate nurse-to- preterm infants' ratio, and a lack of participation in previous neuroprotective care bundle training programs as cleared in the current study finding (table 1). The substantial improvement post-NPCB implementation underscores the importance of regular training for neonatal nurses. This training is crucial for minimizing intraventricular hemorrhage (IVH), alleviating stress and pain in preterm infants. The positive trend is further supported by the increasing educational level of nurses, particularly those with bachelor's degrees, indicating a desire for continuous education and professional development.

The results align with **Metwally et al.'s (2020)** investigation on the "Effect of Preventive Care Bundle Guidelines for Nurses on Incidence of Intraventricular Hemorrhage among Mechanically Ventilated Preterm Neonates" Their study revealed a notable enhancement in nurses' knowledge levels following the implementation of preterm infants' care bundle guidelines. The improvement was statistically significant compared to the pre-guidelines period. This is consistent with the study by **Harrison et al. in 2015,** emphasizing the potential pitfalls of outdated policies in high-risk neonatal care, particularly in the context of adopting updated measures for pain reduction during procedures.

The findings of the present study affirm the hypothesis that knowledge and performance scores significantly improved following the implementation of the NPCB. This aligns with **El Amouri et al.'s (2021)** study, "Reducing Intraventricular Hemorrhage in Preterm Babies Less Than 30 Weeks of Gestation in Neonatal Intensive Care Unit, Level III A Bundle of Care." Their research highlighted the success of standardizing care and educating healthcare providers in the Neonatal Intensive Care Unit (NICU). In the present study, the researchers shared a similar perspective, acknowledging the vital role of standardized care and education in enhancing staff understanding of the pathophysiology of brain damage, emphasizing the importance of minimal handling, and promoting timely and appropriate care.

The vulnerability to IVH is heightened during the first 72 hours after birth, emphasizing the importance of preventive measures within this crucial timeframe. The current study highlighted the improvement in nurses' performance after NPCB implementation. This finding is in harmony with **Zyga, 2022** in his study about "Intraventricular hemorrhage in premature infants. Review of diagnostic methods, treatment and influence on neurodevelopment". The researcher reported that early diagnosis, appropriate nursing care and treatment can minimize IVH morbidity. The prevention of IVH in neonatal care involves implementing enhanced performance, such as the utilization of a NPCB. This includes elevating the head of the incubator bed to 15-30 degrees and maintaining the baby in a midline head and body position. Traditional positioning aids, like bed sheet boundaries, are employed to support and sustain flexion and midline orientation. To minimize pain and stress, a strategy of minimal handling is adopted, reinforced by placing signs on the incubators. Additionally, efforts are made to cover the incubators whenever feasible, aiming to reduce light and noise stimulation.

The current study presented that the rate of seriousness of IVH were significantly decreased after implementation of the NPCB and this finding go online with **El Tatawy & Gad, 2022** in their study about "Care Bundle Application Decreases the Frequency and Severity of Intraventricular Hemorrhage in Preterm Neonates: Single Center Study", according to their findings, the occurrence of IVH markedly decreased in the post-bundle group, with rates dropping from 44-46% before the implementation of the care bundle to 27% afterward. This improvement was notably observed through cranial ultrasonography conducted in the second week of life. Furthermore, the rate of seriousness of IVH demonstrated a positive shift post-bundle, with no Grade III or IVH cases identified in the study group. This outcome suggests advancements in medical and nursing care protocols, emphasizing the importance of incorporating an IVH care bundle into NICUs for enhanced brain protection. It is crucial to note that the successful reduction in IVH incidence requires comprehensive training and education for the

entire NICU staff to ensure effective implementation of these /measures.

The current study affirms a positive association between overall knowledge and performance scores concerning the implementation of the neuroprotective care bundle immediately after educational intervention. This correlation underscores the significance attributed by the researchers to the study's title, emphasizing their pivotal role in preventing short- and long-term complications on neonatal health through adherence to straightforward nursing protocols. **Metwally, et al., (2020)** corroborate these findings, reporting a positive correlation between total knowledge and practice scores both before and after the implementation of educational guidelines for preventing intraventricular hemorrhage (IVH) bundle. This suggests the effectiveness of educational interventions in enhancing healthcare professionals' understanding and implementation of preventive care bundles.

Conclusion and Recommendation

Implementation and methodical application of an IVH care bundle that encompasses postnatal measures surrounding the early birth days of preterm babies can positively affect their neurological outcome by controlling rates of seriousness of IVH. These measures require training and education of bedside nurses on behalf of the entire NICU staff to be thoroughly implemented. As more awareness regarding neuroprotection including brain protection in the preterm newborn is gained, measures such as IVH care bundles will hopefully be considered in all countries around the world and become part of the routine NICU care of preterm babies.

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