Effect of Implementing Bundle of Care Regarding Intraventricular Hemorrhage on Nurses' Performance and Clinical Outcomes for Premature Neonates on Mechanical Ventilator

Abdel Rahman Sobhy Khalefa[1, 2], Rahma Soliman Bahgat[3], Mai Hassan Hassan Elsharkawy[4]

[1]Nursing specialist at Tanta University Hospital, Egypt
[2]Master student at Pediatric Nursing Deptment, Faculty of Nursing, Tanta University, Egypt
[3]Professor of Pediatric Nursing, Faculty of Nursing, Tanta University, Egypt
[4]Assistant Professor of Pediatric Nursing, Faculty of Nursing, Tanta University, Egypt

Corresponding author: **Abdel Rahman Sobhy**
Email: Abdel Rahman Sobhy Khalefa@nursing.tanta.edu.eg

Abstract

Background: Intraventricular hemorrhage is one serious neurological issue that affects morbidity and mortality in premature neonates. **Aim of the study was** to evaluate the effect of implementing bundle of care regarding intraventricular hemorrhage on nurses' performance and clinical outcomes for premature neonates on mechanical ventilator. S**ubjects and Method:** A quasi-experimental research approach was used. **Setting:** The study was carried out at Neonatal Intensive Care Unit of Tanta Main University Hospital's, affiliated to the Ministry of Higher Education and Scientific Research. **Tools of data collection: Tool I**: Nurses' knowledge regarding interventricular hemorrhage structured questionnaire, **Tool II:** Nurses practices Bundle of care Observational checklists regarding Intraventricular Hemorrhage, **Tool III**: Intraventricular hemorrhage grading scale, **Tool IV:** premature neonatal clinical outcomes**. Result: nurses' level of knowledge and practice was significantly increased** after implementation of care bundle, the majority of the neonates maintained normal premature vital signs, reduced intraventricular hemorrhage occurrence and decrease length of hospital stay. **Conclusions:** Bundle of care was effective in improving nurses' knowledge and practices regarding intraventricular hemorrhage for premature neonates on mechanical ventilator and this was reflected on neonatal clinical out come and their length of hospital stay. **Recommendation:** Developing educational programs about preventive bundle of care regarding intraventricular hemorrhage for premature neonates on mechanical ventilator should be done for nurses periodically at neonatal intensive care unit

Keywords: Bundle of care. Intraventricular Hemorrhage, Mechanical Ventilation, Premature Neonates.

Introduction

Approximations about 15 million neonates are born prematurely annually, accounting for about one in ten births worldwide ((WHO). As a result, premature neonates' mortality and morbidity from premature birth is a major global public health worry. Rates of premature birth vary greatly between countries worldwide. Premature birth is less common in high-income countries than in low- and middle-incomes. Although there can be significant variation between countries due to different influences such as income and access to medical care, although; the rate of premature birth is often similar **(Vogel et al., 2019).**

In the United States (2023), 10.4% of births were preterm and 29.8% of births were early term significantly increased from 28.8% in 2021). Globally in 2020, there were an estimated 13.4 million preterm births. Premature neonates, even late premature neonates who are the size of some full-term infants, have increased morbidity and mortality compared to full-term infants because of their prematurity **(Martin, Hamilton, Osterman 2023).**

Premature neonates are often delivered urgently due to pregnancy complications or accidents, requiring specialized care at Neonatal Intensive Care Unit. For clinicians, the speedy priority is to stabilize and save the infant's life. However, in emergencies, the long-term effects of interventions like intubation and hypoxemia events on neurodevelopmental outcomes are often overlooked Panel (**Chen et al., 2025).**

Premature is a neonate who is born before 37 weeks of gestation, there are 15 million preterm births born per year worldwide. The most common problems related to preterm birth are respiratory problems especially in extremely preterm neonates. Respiratory problems occur after birth in preterm neonates due to insufficient surfactant production, weak chest muscles and flexible ribs. So, these neonates should be ventilated to mature and breathe effectively. As a result, the majority of preterm neonates require mechanical ventilation for respiratory support and lifesaving **(Yue, et al., 2021).**

Premature neonates, due to immaturity, frequently experience oxygenation instability, which

manifests as intermittent hypoxemia episodes and can cause vascular damage, leading to unstable cerebral blood flow and increasing the risk of intraventricular hemorrhage Oxygen saturation is commonly used to detect these hypoxemia episodes, but the lack of standardized thresholds makes accurate monitoring challenging **(Siffel, et al., 2021).**

Intraventricular hemorrhage in premature neonates is defined as bleeding into the fluid-filled ventricles of the brain, which are spaces surrounded by brain tissue. This condition is most common in premature babies due to the fragility of their developing blood vessels. IVH is graded based on the extent of bleeding within the brain's ventricles, using the Papile grading system. It ranges from Grade I (mild) to Grade IV (severe), with Grades I and II considered less severe than Grades III and IV **(Allan, 2024)**.

Bundle of care is defined as a combination of measures that have been developed which have shown some promise in preventing intraventricular hemorrhage. The nurses play an important role in managing interventions that will be beneficial to prevent intraventricular hemorrhage, particularly in the first 72 hours of life when preterm neonates are most vulnerable. Most Intraventricular hemorrhage preventive care bundles focus on this critical time **(Garfinkle &Miller, 2020).**

Components of an IVH prevention care bundle include **positioning, Minimal Handling Hemodynamic Stability:** Maintaining stable blood pressure and respiratory function to avoid fluctuations in cerebral perfusion. Creating a quiet, dimly light environment with minimal noise and disturbance to reduce stress and potential for increased cerebral blood flow. **Pain Management and early intervention:** Implementing preventive measures as early as possible in the first 72 hours of life, given the high incidence of IVH in the early days after birth.

Significance of the Study

Intraventricular hemorrhage is a significant neurological complication in premature neonates, affecting morbidity and mortality. Intraventricular hemorrhage primarily arises from unstable hemodynamics and prematurity, with its highest occurrence within the initial five days of a premature neonates' 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).** It is estimated that premature neonates' requirement of mechanical ventilation has increased due to low gestational age and the less mature lungs which raise respiratory support demand. In addition, 60– 95% of premature neonates worldwide require mechanical ventilation after birth. Although, their brains are vulnerable to IVH **(Chan et al., 2020).**

Despite the technological advancements of neonatology, intraventricular hemorrhage continues to be a cause for death of approximately 45 percent of total mortality rate of mechanically ventilated preterm neonates (**Wilson et al., 2020).** The overall incidence for all neonates of 22 to 28 weeks of gestational age is 32% **(Wilson et al., 2020).** Based on weight, intraventricular hemorrhage occurs in 25 to 30% of neonates less than 1500 gram and occurs in up to 45% of neonates less than 1000g.In premature neonates, intraventricular hemorrhage is found to be predominant during first five days of preterm neonates' life. So, application of bundled of care for intraventricular hemorrhage is recommended during the first 72 hours from preterm neonates birth is a critical role for the nurses (**Daigneault et al., 2020).** The present study was aimed to evaluate the effect of implementing bundle of care on nurses' performance and clinical outcomeregarding intraventricular hemorrhage for premature neonates on mechanical ventilator**.**

Research hypotheses

1-Implementing bundle of care is expected to improve nurses' knowledge and practices regarding intraventricular hemorrhage for premature neonates on mechanical ventilator.

2-Implementing bundle of care is expected to reduce occurrence of intraventricular hemorrhage of ventilated premature neonates.

Subjects and Method

Research Design

A quasi-experimental research design was used in the present study.

Setting: The study was conducted at **Neonatal Intensive Care Unit of Tanta Main University Hospital** which is affiliated to Ministry of Higher Education and scientific Research.

Subject: A convenience sampling of (60) nurses who was care for

premature neonates at previously mentioned setting and purposively selected sample of (60) premature neonates.

Inclusion criteria of premature neonates: Premature neonates who require mechanical ventilation in the first 72 hours of birth.

Tools of data collection

Tool I: Nurses' knowledge regarding interventricular hemorrhage structured questionnaire. It is designed by the researcher after reviewing the relating literature and comprises two parts **(Gross, et al., 2021; El Amouri, 2021).**

Part (I): Socio-demographic characteristics of nurses: It included nurses' characteristics such as age, sex, qualifications, years of experiences and previous training courses

Part (2): Present and past medical history of premature neonates: It included characteristics of premature neonates. The data obtained from the hospital medical record of preterm neonate. It will include gestational age, gender, weight on admission vital signs, length of stay, and mode of mechanical ventilation.

Part (3): Nurses, knowledge regarding intraventricular hemorrhage for premature neonates on mechanical ventilator :

This tool was developed after reviewing related literature. **(Kolnik, et al., 2023),** i**t includes the following**

a. **Mechanical ventilation** Definition, indication, modes, weaning criteria complications and nursing care.
b. **Intraventricular hemorrhage such a**s: Definition, signs and symptoms, grads, causes, and complications.

Scoring system of Nurses' Knowledge

- Correct and complete answer scored (2)
- Correct and incomplete answer scored (1)
- Wrong answer or don't know scored (0)

Total score of nurses' knowledge classified as

- Less than 60%: low level of knowledge.
- From 60 to less than 80 %: moderate level of knowledge.
- From 80 to 100 %: high level of knowledge.

Tool II: Nurses practices Bundle of care Observational checklists regarding Intraventricular Hemorrhage: It was used for assessing nurses' practice and includes bundle practices such as

1-Respiratory interventions

Maintaining midline head position -Elevation of head of bed.-Short time of suction.-Avoiding chest physiotherapy.

2-Slow withdrawal of blood samples

Drawing of blood samples from lines with subsequent flushing should be performed slowly (1.5 mL/30 sec) to avoid blood pressure fluctuations.

3-Premature neonates positioning

Tilting the incubator to achieve 10 to 20 degrees upper body elevation during the first week of life. Supine midline position for three days with neutral head positioning. Avoidance of prone position during the first week of life.

4-Cranial ultrasound

The first cranial ultrasound must be performed on the fourth day of life.

5-Care procedures

Administration of glucose–glycerol enemas every 12 hours during the first three days of life.

Using closed suction systems on mechanically ventilated neonates if needed. -Measuring head circumference and body length on the fourth day of life. -Measuring weight on admission, then on the fourth and seventh day of life.

5-Minimal stimulation

Using of individual tactile stimulation during nursing care.

6-Prevention of infection

Infection control precaution while dealing with premature neonates nurse must: -

- Wear mask, overhead, over shoes, sterile gown, and gloves.
- All instruments used should be sterilized and everything entering to neonates should be clean as feeding with sterile bottle),
- Monitor vital signs every 4 hours-Measure weight daily.

5- Light and sound environment.

- Avoiding constant light exposure by covering the incubator.
- Visual monitoring must be provided.
- Avoiding noise by setting alarm tones as quietly as possible.
- Do not place objects on the incubator.
- Avoiding noisy conversations near the incubator.

6- Maintain regulation of normothermia.

8-Prevent occurrence of hypotension.

- Slow administration of fluid boluses-Slow flushing of umbilical venous catheter and center line.

7- Hygienic care.

- Routine change of diaper.
- Bathing daily with small cotton balls.

- Skin care

Nurses' practice was scored as follow:

-Done correctly was scored (1).

-Not done was scored (0).

Total practice score was calculated as follow:

-From 80%- 100%: satisfactory practice

-Less than 80%: unsatisfactory practice

Tool III: Intraventricular hemorrhage grading scale

It was adopted by **Volpe et al., 2017.** It is a grading system for intraventricular hemorrhage which is based on cranial ultrasonography findings.

It was used to measure the occurrence of intraventricular hemorrhage before and after implementing of preventive care bundle.

Intraventricular hemorrhage grades in cranial ultrasound determined according to intraventricular hemorrhage grading scale as;

- Grade (1): when blood filled < 10% of ventricle.
- Grade (2): when blood filled 10%–50% of ventricle.
- Grade (3): when blood filled >50% of ventricle.
- Grade (4): when Periventricular infarction occurs.

Tool IV: premature neonatal clinical outcomes

-Normal body weight

- Normal temperature, heart and respiratory rate

-Maintain normal blood pressure.

-Reduce occurrence of intraventricular hemorrhage

-Maintain skin integrity

- Reduce length of hospital stay.

Methods

1. An official approval obtained from the responsible authorities.
2. Ethical and legal consideration:

a) Ethical approval was obtained from the scientific ethical committee in the faculty of nursing at Tanta University before starting the study code No (415/3/2024).

b) The nature of the study caused no any harm or pain to the entire subject.

c) The researcher assured of maintaining anonymity, confidentiality and privacy of the subject data.

3. Care providers informed that they are allowed to participate in the study and they have the right to withdraw from the study at any time
4. The tools of the study translated by the researchers to Arabic language. (tool II, III)
5. The tools presented to a jury of to

check content validity and clarity of tools.

6. Suitable statistical tests used for testing tool's reliability.
7. A pilot study conducted on (10%) of care providers six nurses to test the feasibility and applicability of the tools
8. Data collected within six months.

a) The present study conducted through four phases as follow:

Assessment Phase (Pretest): Assessment of the nursing staff and premature neonates done by using (Tool I, Tool II, Tool III) at the morning shift.

Planning Phase

The researcher's prepared the material in straightforward Arabic and practical English; this illustrated organized colorful booklet based on a literature study and includes instructive visuals illustration to aid with comprehension.

Implementation Phase

-Implementation of nursing care bundle focusing on interactive learning and active participation using different teaching methods such as lectures, group discussion, in addition to different audiovisual materials as pamphlets, pictures, posters and video to facilitate teaching. The bundle of nursing care delivered on sixth sessions and administered during morning shift starting, each session lasted from20-30 minutes.

The first session

Focused on mechanically ventilated premature neonates as definition, causes, complications, and nursing care.

The second session

Focused on intraventricular hemorrhage such as definition, signs and symptoms, grads, causes, and complications.

The third session: Focused on intraventricular hemorrhage bundle of care practices such as premature neonates mechanically ventilation care such as; maintain midline head position, elevate head of bed, maintain normothermia, and prevent occurrence of hypotension

The fourth session: Focused on slow withdrawal of blood samples, respiratory interventions, and minimal stimulation light and sound environment

The fifth session: Focused on avoiding chest physiotherapy and suction and perform skin care

The sixth session: Focused on infection control precautions.

Evaluation Phase: Nursing staff and premature neonates assessed by using (Tool II, Tool III) pre and immediately after implementing nursing care bundle.

Results

Table (1) revealed that the majority of the studied nurses were aged between 25–35 years, predominantly female, and most were married. Half of the nurses held a diploma from a technical nursing institute, while one-third had a bachelor's degree. Regarding experience, a considerable proportion was between 5 to 10 years of clinical practice. Notably, none of the participants had received prior training on intraventricular hemorrhage (IVH) care in premature neonates, highlighting a significant gap in targeted educational exposure relevant to the study topic. Regarding gestational age, the majority of neonates (85%) were born between 28 and 32 weeks of gestation, while only 15% were less than 28 weeks. As for gender distribution, males represented a higher proportion (65%) compared to females (35%). Concerning the type of mechanical ventilation used, the most commonly applied mode was SIMV (Synchronized Intermittent Mandatory Ventilation), accounting for 40% of the cases, followed by HFOV (High-Frequency Oscillatory Ventilation) at 30%. Both CPAP (Continuous Positive Airway Pressure) and Conventional Mechanical Ventilation were equally used in 15% of neonates.

Table(2) clarifies that the majority of neonates (85%) were born between 28 and 32 weeks of gestation, while only 15% were less than 28 weeks, In addition; males represented a higher proportion (65%) compared to females (35%). Concerning the type of mechanical ventilation used, the most commonly applied mode was SIMV (Synchronized Intermittent Mandatory Ventilation) which accounting for 40% of the cases.

Table (3) shows that Pre-intervention, the majority of nurses (60%) demonstrated low knowledge, while only 11.7% achieved a high knowledge level.).

Controversy, post the intervention, there was a marked shift: 90% of nurses attained a high knowledge level, while none remained in the low category as the Chi-square test revealed a statistically significant difference ($\chi^2 = 77.472$, $p = 0.001$), indicating a strong association between the intervention and improved knowledge.

Table (4): It represented that a highly significant improvement in nursing practice was observed post-intervention. As prior to the implementation of the care bundle, 63.3% of nurses exhibited

unsatisfactory practice compared to 90% demonstrating satisfactory practice post-intervention (χ^2 = 55.610, p = 0.001). This highlights the effectiveness of the implemented bundle in enhancing clinical nursing practice.

Table (5): illustrates statistically significant and strong positive relationship between knowledge and practice. (r = 0.674, p = 0.001). This suggests that nurses with higher knowledge levels about IVH management tended to perform better in clinical practice, reinforcing the importance of continuous education and training

Table (6): shows that there is a statistically significant association between years of experience and knowledge level (p = 0.031), indicating that increased clinical experience positively correlates with higher knowledge regarding intraventricular hemorrhage (IVH) care.

On the other hand; the result of the current study proved that none of the demographic variables, including age (p = 0.632), gender (p = 0.061), marital status (p = 0.112), educational background (p = 0.290), or years of experience (p = 0.129), were significantly associated with the mean practice scores of nurses.

Table (7): illustrates that high statistically significant improvement across all areas of nursing care practices (p = 0.001) post-implementation. As Key domains such as respiratory interventions, infection prevention, appropriate neonatal positioning, cranial ultrasound procedures, and minimal stimulation showed remarkable progress. For example, adherence to "elevation of head of bed" increased from 36.7% to 95%, and monitor and record vital signs every 4 hours improved from 60% to 100%. These findings confirm the positive impact of the care bundle in standardizing and enhancing nursing interventions for ventilated premature neonates at risk of IVH.

Table (8): demonstrates that a statistically significant improvement was observed in several parameters post-intervention. As Weight increased significantly from a mean of 1132.5 gram to 1235 gram (p = 0.003), Heart rate decreased from a mean of 185 beat/minute to 168.7 beat/minute (p = 0.001), indicating improved cardiovascular stability, Respiratory rate also showed a significant decrease from 70 to 55.3 breaths/min (p = 0.001), suggesting better respiratory function.

Also, Systolic and diastolic blood pressure improved significantly

post-intervention (p = 0.001 for both). And Temperature regulation showed slight but significant improvement (p = 0.008).

Regarding Hospital stay duration showed a marked improvement, with a short mean length of stay recorded at 23.6 days post-intervention (p = 0.001), indicating enhanced recovery and efficiency of care.

However, hemorrhage grade did not show statistically significant changes (p = 0.715), indicating that while general physiological parameters improved, IVH severity remained relatively stable.

Table 1: Percentage distribution of the studied nurses according to socio-demographic characteristics

Socio-demographic characteristics	Studied (n=60)	
	No	%
Age		
25 –> 35	32	56.33
35 –45	22	36.7
> 45	6	10
Range	25 – 47	
Mean ± SD	35.42 ± 6.33	
Sex		
Male	15	25
Female	45	75
Marital status		
Married	43	71.7
Unmarried	17	28.3
Education level		
Secondary Nursing Diploma	10	16.7
Technical Nursing Institute	30	50
Bachelor of Nursing	20	33.3
Years of Experience		
< 5 years	23	38.3
5 – 10 years	26	43.3
> 10 years	11	18.3
Training sessions on IVH in premature neonates		
No	60	100
Yes	0	0

Table (2) Percentage distribution of the studied premature neonates according to their Bio-socio-demographic Characteristics

Bio-socio-demographic Characteristics	Study (n=60)	
	N	%
Gestational Age		
< 28 weeks	9	15
28 – 32 weeks	**51**	**85**
Gender		
Male	**39**	**65**
Female	21	35
Type of Mechanical Ventilation on the ventilator		
CPAP	9	15
HFOV	18	30
SIMV	**24**	**40**
Conventional MV	9	15

Table (3): Percentage distribution of the nurses' total knowledge score regarding intraventricular hemorrhage of premature neonates on mechanical ventilator.

Total Knowledge score	The studied groups (n=60)				χ^2	P
	Pre		Post			
	No	%	No	%		
Low	36	60	0	0		
Moderate	17	28.3	6	10	77.472	0.001*
High	7	11.7	54	90		

Table (4): Percent distribution of total Nurses' practices regarding Intraventricular Hemorrhage for premature neonates on mechanical ventilator.

Practice	The studied groups (n=60)				χ^2	P
	Pre		Post			
	N	%	N	%		
Unsatisfactory	38	63.3	0	0	55.610	0.001*
Satisfactory	22	36.7	60	100		

X^2: Chi square test * Significant p value < 0.05

Table (5): Correlation between total knowledge score of the studied nurses and their total practices regarding Bundle of Care for Intraventricular Hemorrhage

	Knowledge	
	r.	p
Practice	0.674	0.001*

r: Pearson correlation * Significant p value < 0.05

Table (6): Relation between the studied nurses' knowledge regarding intraventricular hemorrhage for premature neonates on mechanical ventilator and their Socio-demographic characteristics.

Socio-demographic characteristics			Knowledge		X^2	P-value
			Moderate	High		
Age	**25 – 35 y**	**N**	3	29	0.330	0.848
		%	50.0%	53.7%		
	35 – 45 y	**N**	2	20		
		%	33.3%	37.0%		
	> 45 y	**N**	1	5		
		%	16.7%	9.3%		
Gender	**Female**	**N**	4	42	0.373	0.542
		%	66.7%	77.8%		
	Male	**N**	2	12		
		%	33.3%	22.2%		
Martial status	**Married**	**N**	3	43	2.650	0.104
		%	50.0%	79.6%		
	Unmarried	**N**	3	11		
		%	50.0%	20.4%		
Educational	**Secondary Nursing Diploma**	**N**	2	8	1.481	0.477
		%	33.3%	14.8%		
	Technical Nursing Institute	**N**	2	18		
		%	33.3%	33.3%		
	Bachelor of Nursing	**N**	2	28		
		%	33.3%	51.9%		
Experience years	**< 5 y**	**N**	3	19	6.970	0.031*
		%	50.0%	35.2%		
	50 - 10 y	**N**	3	8		
		%	50.0%	14.8%		
	> 10 y	**N**	0	27		
		%	0.0%	50.0%		

Table 7: Percentage distribution of the studied nurses' practices regarding Intraventricular Hemorrhage pre and post Implementation of Care Bundle

Items of the practice	The studied groups (n=60)									
	Pre				Post				P value	X2
	Done		Not done		Done		Not done			
	No	%	No	%	No	%	No	%		
Respiratory interventions										
Maintaining midline head position.	18	30	42	70	58	96.7	2	3.3	0.001*	64.618
Elevation of head of bed.	22	36.7	38	63.3	57	95	3	5	0.001*	52.001
Short time of suction.	23	38.3	37	61.7	55	91.7	5	8.3	0.001*	49.192
Avoiding chest physiotherapy.	25	41.7	35	58.3	56	93.3	4	6.7	0.001*	42.549
Slow withdrawal of blood samples	24	40	36	60	54	90	6	10	0.001*	51.432
Premature neonates positioning										
Tilting the incubator to achieve 10 to 20 degrees body elevation during the first week	20	33.3	40	66.7	53	88.3	7	11.7	0.001*	60.001
Supine midline for three days with neutral head positioning.	15	25	45	75	55	91.7	5	8.3	0.001*	72.001
Avoidance of prone position during the first week	18	30	42	70	56	93.3	4	6.7	0.001*	60.291
Cranial ultrasound	21	35	39	65	57	95	3	5	0.001*	50.721
Care procedures										
Administration of glucose–glycerol enemas every 12 hours during the first three days of life.	23	38.3	37	61.7	59	98.3	1	1.7	0.001*	53.487
Using closed suction systems on mechanically ventilated neonates if needed.	18	30	42	70	60	100	0	0	0.001*	64.618
Measuring head circumference and body length on the 4 day	19	31.7	41	68.3	56	93.3	4	6.7	0.001*	58.162
Measuring weight on admission, then on the fourth and seventh day of life.	21	35	39	65	58	96.7	2	3.3	0.001*	57.781
Maintaining of minimal stimulation										
individual tactile stimulation during nursing care.	22	36.7	38	63.3	56	93.3	4	6.7	0.001*	52.001

Continue: Table 7: Percentage distribution of the studied nurse's practices regarding Intraventricular Hemorrhage pre and post Implementation of Care Bundle

Items of the practice	The studied groups (n=60)									
	Pre				Post				P value	X2
	Done		Not done		Done		Not done			
	No	%	No	%	No	%	No	%		
Prevention of infection										
Wear personal protective barriers.	20	33.3	40	66.7	57	95	3	5	0.001*	60.001
All instruments used and entering to neonates should be sterilized and cleaned as feeding with sterile bottle	19	31.7	41	68.3	58	96.7	2	3.3	0.001*	55.132
Monitor and record vital signs every 4 h	21	35	39	65	60	100	0	0	0.001*	57.779
Measure weight daily.	22	36.7	38	63.3	56	93.3	4	6.7	0.001*	55.612
Light and sound environment										
Avoid constant light exposure by covering the incubator.	20	33.3	40	66.7	58	96.7	2	3.3	0.001*	60.001
Provide visual monitoring	23	38.3	37	61.7	59	98.3	1	1.7	0.001*	53.486
Setting alarm tones as quietly as possible.	24	40	36	60	58	96.7	2	3.3	0.001*	51.429
Do not place objects on the incubator.	22	36.7	38	63.3	57	95	3	5	0.001*	55.612
Avoid noisy conversations	21	35	39	65	55	91.7	5	8.3	0.001*	54.149
Maintain Normothermia										
Apply measures to prevent hypothermia and hyperthermia.	20	33.3	40	66.7	59	98.3	1	1.7	0.001*	60.001
Prevent the occurrence of hypotension										
Slow administration of fluid boluses	21	35	39	65	56	93.3	4	6.7	0.001*	57.779
Slow flushing of umbilical venous catheter and center line.	22	36.7	38	63.3	58	96.7	2	3.3	0.001*	55.612
Hygienic care										
Routine and when needed diaper change	21	35	39	65	59	98.3	1	1.7	0.001*	54.149
Bathing daily using cotton balls.	22	36.7	38	63.3	56	93.3	4	6.7	0.001*	55.612
Apply regular skin care	23	38.3	37	61.7	55	91.7	5	8.3	0.001*	53.486

* Significant p value < 0.05

Table 8: Mean scores of the studied premature neonates according to their clinical outcomes pre and post Implementation of Care Bundle

premature neonates clinical outcomes		Range	Mean ± S. D	t. test	p. value
Weight	Pre	800 – 1500	1132.5 ± 181.99	3.001	0.003*
	Post	1000 – 1700	1235 ± 192.07		
Recorded weight	Pre	900 – 1700	1217.5 ± 203.12	0.067	0.947
	Post	900 – 1700	1215 ± 204.26		
Heart Rate	Pre	155 – 185	168.7 ± 8.62	17.618	0.001*
	Post	140 – 155	147 ± 4.08		
Respiratory rate	Pre	60 – 80	70 ± 6.30	14.304	0.001*
	Post	45 – 60	55.3 ± 4.87		
Systolic	Pre	45 – 68	55.12 ± 5.17	17.706	0.001*
	Post	64 – 72	68 ± 2.25		
Diastolic	Pre	28 – 40	32.85 ± 3.19	15.956	0.001*
	Post	35 – 45	40.9 ± 2.25		
Hospital stay	Pre	1 – 4	2.8 ± 0.88	80.902	0.001*
	Post	21 – 29	23.6 ± 1.79		
Hemorrhage grade	Pre	1 – 4	2.5 ± 0.81	0.367	0.715
	Post	1 – 3	2.45 ± 0.67		
Temperature	Pre	35.5 – 37.5	36.47 ± 0.62	2.688	0.008*
	Post	35.8 – 37.5	36.725 ± 0.40		

Discussion

The current findings demonstrated that about third of the studied nurses aged between 25 to 35 year which is consistent with **Mohamed (2018)** who carried out a study to assess quality of nursing care provided for preterm neonates of low birth weight with intraventricular hemorrhage and stated that the nurses under study had an average age of 29.45± 9.67,

Also **Metwally, et al. (2020)** mentioned that; the studied nurses mean age was 28.83±6.23 years

Regarding the gender of the nurses under study, the present study found that three-quarters of the nurses were female. This finding may be attributed to the fact that historically, the majority of nursing personnel were female. This outcome is consistent with many other studies;

Metwally, et al. (2020), and Elsobkey and Amer (2018)

Regarding educational attainment, the current study's findings showed that half of the nurses under investigation received their degrees from Technical Nursing Institutes. , controversy **Metwally, Abd-allah, and Mohammed (2020),** proved that less than half of the studied nurses received bachelor of nursing science and **Alsharkawi et al. (2019)** and **Elsobkey and Amer (2018)** who noted that over half of the nurses received their degrees from nursing schools.

These observations are consistent with findings from various other studies **(Macho 2018 & El Amouri et al., 2021)**

Regarding years of experience, the current study's findings indicated that fewer than half of the nurses under investigation had five to ten years of experience and none of them experience previous training sessions about IVH in premature neonates; which attributed 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. The results are in consistent with the studies **Metwally, et al. (2020), Hassanen (2023), Mohamed (2018)** and **Abo-Elezz et al., (2019)**

Concerning to studied premature neonates gestational age, gender, and mode of mechanical ventilation; the study result illustrated that; most of the neonate's gestational age is ranging from 28 to 32 weeks, more than half are males and less than half are under SIMV mode of ventilation; similar to other studies; **Hassanen (2023)** stated; over two-thirds of the preterm infants under scrutiny were male while **Metwally et al., (2020)** said that over half of

each newborn group is made up of male neonates, around two thirds.

Wallau et al., (2020) showed that 59.0% of preterm infants were males. Similarly, **Kumar et al. (2020)** demonstrated that male preterm newborns made up over half of the groups under study.

Accordance to **Gross et al., (2021)** who contradicting the present study result and reported that the mean gestational age of the studied premature neonates is 27.9 ± 2.5 weeks while most of them undergoing CPAP mode of mechanical ventilation. Also, **Metwally , et al.,(2020)** disagreed with the result of the present study and claimed that, in comparison to half of the control group, less than two thirds of the preterm neonates in the research group entered PPV mode. This outcome is consistent with **Ozek and Gulcan, (2020)** discovered that the prevalence of intraventricular hemorrhage (IVH) is higher when mechanical ventilation is present in preterm infants.**Egwu et al., (2019)** said that CPAP, or respiratory assistance, was a major risk factor for IVH.

The present study results demonstrated that there was a high statistically significant improvement ($p = 0.001$) across all knowledge items of nurses regarding premature ventilated neonates **Abo-Elezz (2019)** supported the current study's findings and demonstrated that the nurses' understanding of the definition, causes, clinical picture, and treatment of intraventricular hemorrhage had improved significantly both immediately and one month after the intervention. **Metwally, Abd-allah & Mohammed (2020)** agreed with the current study result and mentioned that about two thirds of the studied nurses had poor level of knowledge pre neonatal care bundle guidelines with statistically significantly improvement when compared to pre-neonatal care bundle guidelines.

In the same line; **Kunswa (2018)** concurred with the study's findings and said that students' understanding of the concept of developmental supportive care demonstrated a noticeable improvement in their knowledge that demonstrated the program's beneficial effects.

As related to nurses' practice of care regarding intraventricular hemorrhage, The current study's findings for premature neonates on mechanical ventilators showed that, prior to implementing the bundle of care regarding intraventricular hemorrhage, roughly two thirds of the nurses who were the subject of the study initially performed in an unsatisfactory manner, while only a

small percentage of them demonstrated satisfactory practice.

Abo-Elezz et al. 2019 , **Metwally, Abd-allah & Mohammed 2020), (Hassanen 2023)** and (**Travers et al. 2022)** is in the same line with the present study result and identified that nurses demonstrated poor practice regarding prevention with the treatment of intraventricular hemorrhage prior to the nursing intervention, which considerably improved both immediately and one month later. Likewise same result was agreed with other studies.

Also **Ahmed et al. (2013); Elsobkey and Amer (2018), Lombardo (2018); Shehab, Ibrahim and Elkader** (**2018)** stated that after the educational guidelines program was put into place, nurses' practice greatly improved and now offers competent, adequate, and effective practice and found the educational intervention advances nursing proficiency and skills in identifying IVH.

Regarding the relationship between nurses' overall knowledge and practice With regard to the bundle of care for intraventricular hemorrhage, the study's findings indicate a positive correlation between the nurses' overall knowledge and practice level. This difference is highly statistically significant, indicating that nurses with greater IVH management knowledge tended to practice better, highlighting the significance of ongoing education and training in lowering the incidence of IVH in preterm neonates.

Shehab, Ibrahim and Elkader (**2018) and Metwally, Abd-allah & Mohammed (2020)** supported the result of the present study and found that, just after the program was put into place, there was an extremely substantial positive association between total knowledge and total practice score.

The result of the present study revealed a statistically significant relation between years of experience and knowledge level of the studied nurses while no correlation was found between socio-demographic characteristics of the nurses and their total practice level, **Lipson et al., (2014); Kumar et al., (2020)** ; **Alotaibi et al., (2020)** was completely in line with the study's findings and showed that years of experience and knowledge were positively correlated, but practice showed no discernible relationship.

The result of the present study proved that a statistically significant improvement was observed in several parameters of clinical outcomes among premature infants post-intervention.

This finding is in agreement with **Bijl Marcus et al., (2020)** who said that the use of a bundle of nursing interventions is linked to improved clinical outcomes and a decreased risk of IVH in preterm newborns. In the same way, **El Tatawy et al., (2022)** added that the incidence and severity of IVH significantly decreased with the adoption of a care package that encouraged neuroprotection.

Travers (2022) ;**Bijl Marcus et al., (2020); Ferreira et al., (2020); Alotaibi et al., (2020)** agreed with the outcome and demonstrated that a thorough, evidence-based quality improvement program was linked to better results during the first week following delivery.

Likewise, these results are consistent with **Wallau et al., (2020), Benlamri, et al., (2022), Travers (2022) ; El Tatawy & Gad, (2022)** who noted that preventing intraventricular hemorrhage by implementing a series of measures can reduce hemodynamic instability and the prevalence of IVH in preterm newborns. Also, this outcome is consistent with IVH is a major concern in preterm infants, according to the study "Neuroprotection care bundle implementation is associated with improved long-term neurodevelopmental outcomes in preterm infants."

Conversely, this study is contradicting with **Gross et al., (2020)** who found that the use of care bundles was not linked to a decrease in the overall rate of IVH or its severity.

Neonatal nurses 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 **(Garfinkle & Miller, 2020; Al-Haddad, 2022).** In the first 72 hours of life, when preterm neonates are most at risk, nurses are crucial in overseeing interventions that will help prevent intraventricular hemorrhage. Nurses should be aware of even little changes since a major decline might be avoided if changes are detected early (**Kaditis et al., 2016)**

About two-thirds of the nurses in the study initially showed poor knowledge, and only a small percentage showed good knowledge regarding the care of premature neonates prior to implementing the bundle of care regarding intraventricular hemorrhage. However, the study's findings showed that the nurses' knowledge level regarding intraventricular

hemorrhage has significantly and dramatically improved since the implementation of the bundle of care.

Regarding IVH grades in the preterm neonates; the present study finding revealed that the IVH grade ranging from 1-4 in the pre and from 1-3 post implementation of bundle of care regarding intraventricular hemorrhage for premature neonates on mechanical ventilator, yet there is no statistically significant differences between the hemorrhage grads in the pre comparing to post implementation of bundle of care. **Romantsik, Calevo, Bruschettini (2020)** were in accordance and demonstrates that; half of the studied premature mechanically ventilated neonates had IVH grade IV in control group compared with less than two thirds had IVH grade III in study group with statistical significant difference. This result may be due to small percentage of very low birth weight neonates in the study and control groups as those are considered the highest critical cases.

The finding of the current study is on the same scope with **Kumar et al., (2020)** who found that higher incidence of severe IVH was in very low birth weight. Conversely, this study is contradicted with **Daigneault et al., (2020)** who found that only 3% of the studied preterm infants had IVH grade III and IV. Moreover, **Alotaibi et al., (2020)** illustrated that 6.4% of the studied preterm neonates had sever IVH.

Regarding correlation between total nurses' knowledge, practice and incidence of intraventricular in preterm neonates, the study result reflects that, there is a negative correlation between total knowledge of nurses, their practice and incidence of IVH pre and post-preventive care bundle guidelines with highly statistical significant difference. **Hassanen (2023)** supported the presented study finding and mentioned that the rate of seriousness of IVH was significantly decreased after implementation of the neuro-protective care bundle.

Conclusions

Bundle of care was effective in improving nurses' knowledge and practices regarding intraventricular hemorrhage for premature neonates on mechanical ventilator and this was reflected on neonatal clinical out come and their length of hospital stay.

Recommendations

1-Developing Educational programs on preventive bundle of care regarding intraventricular

hemorrhage should be done periodically to neonatal intensive care unit nurses.

2. Provided written policies regarding preventive nursing bundle of care related to intraventricular hemorrhage on mechanical ventilation for nurses at neonatal intensive care unit.

References

Abo-Elezz A., Alseraty W., Farag W. (2019). Effect of nursing intervention guidelines on nurses' knowledge and performance regarding prevention and management of intraventricular hemorrhage among preterm neonates. *Journal of Nursing and Health Science, 8*(3), 62-74.

Ahmed,G., Mohammad, H., Assiri, M., &Ameri, A., (2013). Effect of instructional sessions on nurses' and doctors' knowledge and practice regarding developmental care in nicu in abha city, *Journal of Education and Practice 20*(4), 23

Allan W, Sobel D., (2024). Neonatal intensive care neurology. *Semin Pediatr Neurol;* Jun; 11 (2): 119-28.

Alotaib W.,Alsaif N. S.,AhmedA. And Mahmoud A. F. (2020): Reduction of severe intraventricular hemorrhage. *Child's Nervous System*, *36*(11), 2971 2979.

Benlamri, A., & Murthy, P., Zein, H., Thomas, S., (2022). Neuroprotection care bundle implementation is associated with improved long-term neurodevelopmental outcomes in extremely premature infants. *Journal of Perinatology*. *42*. 10.1038/s41372-022-01443 0.

Berthaud J., Morgenstern L., Stroke D. (2020). Medical therapy of intracerebral

Bijl-MarcusK. ,Brouwer A. Vries L.D., Groenendaal F. & Wezel-Meijler G. (2020): Neonatal care bundles are associated with a reduction in the incidence of intraventricular hemorrhage in preterm infants. *Arch Dis Child Fetal Neonatal*Ed., *105*(4),419-424.

Chen, Y. T., Wu, H., Lan, H., Peng, Chang, Y. (2025). Effects of intubation and hypoxemia on intraventricular hemorrhage in preterm infants during the first week: An observational study. *Heart & Lung, 78–86.* https://doi.org/10.1016/j.hrtlng.2024.09.013

Colm P., Travers S, Amelia E. Freeman, Kim Nichols, Vivek V. (2022). A Quality improvement bundle to improve outcomes in extremely preterm infants in the first week. *Journal of Pediatrics 19*(2),

Csaba S, Kristin D, Juliana F , Sujata P Sarda. (2021). Global incidence of bronchopulmonary dysplasia among extremely preterm

infants: a systematic literature review. *Journal of Maternal-Fetal Neonatal Med.8(*1)

Daigneault, J., White, H., Dube, A., Shi, Q., Gauguet, J.M., & Rhein, L. (2020). Lack of progression of intraventricular hemorrhage in premature infants: implications for head ultrasound screening. *Global Pediatric Health, 8*, 2333794X211010729.

de Bijl-Marcus, K., Brouwer, A., De Vries, L., Groenendaal, F., & van Wezel-Meijler, G. (2020). Neonatal care bundles are associated with a reduction in the incidence of intraventricular haemorrhage in preterm infants: a multicentre cohort study. Archives of Disease in Childhood – Fetal and Neonatal Edition, 105(4), 419–424.

Egwu C., OgalaW., FaroukZ., Tabari A. M. and Dambatta A. H. (2019). Factors associated with intraventricular hemorrhage among preterm neonates in Aminu Kano Teaching Hospital. Nigerian Journal of ClinicalPractice,22(3):298-304.

El Amouri, S., Bystricka, A., Paulose, A., Maqbool Khan, Q., Junaid Muhib, J. (2021). Reducing Intraventricular hemorrhage in preterm babies less than 30 weeks of gestation in neonatal intensive care unit, level iii: a bundle of care. *Journal of Clinical Neonatology 10*(3), 165-169.DOI: 10.4103/jcn.jcn_213_20.

El Tatawy, S., Gad, A., Eissa, T., EL Houchi, S., & Sabry, A. (2022). Care Bundle Application Decreases. The Frequency and Severity of Intraventricular Hemorrhage Neonates: *Sciences Single Center Journal,2*(2),10.21608/cupsj.2022.142531.1061 in Preterm Study. Pediatric 112-119.

Elguoshy Hassanen, E., Hassan, R., Abu Samra, O. M., El-Refaay, E. R., & Badawy, G. (2023). Evaluating the effect of a neuro-protective care bundle for neonatal nurses on rate of seriousness of intraventricular hemorrhage among preterm infants. Egyptian Journal of Health Care, 14(4).

Elsobkey F. A. andAmer S. A.M. (2018). Effect of educational guidelines program about nursing care of neonates receiving continuous positive airway pressure. *Journal of Nursing and Health Science.* 7(3), 16-26.

Ferreira, D., Girão, M. , de Silva, M., Chaves, E. , de Almeida, A., & de Carvalho, M. (2020). Impact of bundle implementation on the incidence of peri-intraventricular hemorrhage among preterm infants: a pre-post interventional study. *Journal of Perinatal & Neonatal Nursing*, DOI:10.1097/

Garfinkle J., Miller S. (2022). Neurological Problems in the Newborn, 8thEd,.United States of America, Elsevier Co.,011

Gross M., Engel C. and Trotter A. (2021): Effect of a neonatal care bundle for the prevention of intraventricular hemorrhage in preterm infants. *Children, 8*(257): 1-11.

Guinsburg R. (2020). Impact of bundle implementation on the incidence of peri/intraventricular hemorrhage among preterm infants. *Medical Journal,* 139(6): 251-258. https://doi.org/10.1542/peds.2020-037341.

Hendy, A., AlSharkawy, S., & Abd Al Moniem, I. (2020). Nursing Competency for Caring of High Risk Neonates at Neonatal Intensive Care Unit. *Egyptian Journal of Health Care, 11*(2), 200–213.

Jou Chen, Ti Yin RN, JenJiuan Lia w, Yue-Cune Chang (2024). Effects of intubation and hypoxemia on intraventricular hemorrhage in preterm infants during the first week. *Heart & lung Journal*. *69* (1), 78-86.

Kaditis, N. (2016) Respiratory disordered at neonatal period: diagnosis and management. *European Respiratory Journal*. 63-75.

Kumar P., Carroll K., Prazad P., Raghavan A., Waruingi W. and Wang H. (2020). Elevated supine midline head position for prevention of intraventricular hemorrhage in VLBW and ELBW infants: a retrospective multicenter study. *Journal of Perinatology, 41*(2), 278-285.

Lipson, A., Hausam, A., Higgins, P., &Burant, C., (2014). Knowledge, attitudes, and predictors of advance directive discussions of Registered Nurses. *Western Journal of Nursing Research*, 26(7), 784-796.

Lombardo, k., (2018). Improving advanced practice nurses' knowledge of cerebral hemorrhage assessment and management, *doctorate thesis,* 30-35

Macho, P., (2018): Nurses' Knowledge, Attitudes, and Perceived Self competency Regarding Individualized Developmental Care in the Neonatal Intensive Care Unit, University of New York , Dissertations, Theses, and Capstone Projects Graduate:40-60.

Metwally H, Abd-allah R & Mohammed E. (2020). Effect of preventive care bundle guidelines for nurses on incidence of intraventricular hemorrhage among mechanically ventilated preterm Neonates. *Egyptian Journal of Health Care* 1(2),26

Mohamed F. (2018). Quality of nursing care provided for preterm neonates of low birth weight with intraventricular hemorrhage. *Assiut Scientific Nursing Journal*, *6*(14), 1-11.

Mona Ali Kunswa Orban Ragab Bayoumi (2018). Evidence Based Nursing Practices of Developmental Supportive Care for Preterm Neonates: Intervention Program for Internship Nursing Students. *Journal of Nursing and Health Science*.*7*(1), 50-68.

Osterman, M. J. K., Hamilton, B. E., & Martin, J. A. (2023). Births: Final data for 2021 (*National Vital Statistics Reports, 72*(1),53).

Ozek E. and Gulcan S. (2020). Intraventricular hemorrhage in preterm babies. *Turk Pediatric Ars, 55*(3), 215-221.

Parada, M., Mateo, R., Pueblo, V., López L, Hernández, E.,& Mansilla, F. (2020). Born too early and too small. *Journal Pediatric Premature neonates Health, 3(1)*,1940:942. . https://doi.org/10.3389/fpsyg.2019.01942

Payne V, Hall M, Prieto J, Johnson M. (2020). Care bundles to reduce central line associated bloodstream infections in the neonatal unit: a systematic review and meta-analysis. *Arch Dis Child Fetal Neonatal.;10*3(5),https://doi.org/10.1136/archdischild-2017-313362.

Romantsik, M., Calevo, M. Bruschettini, A. (2020). Head midline position for preventing the occurrence or extension of germinal matrix intraventricular hemorrhage in preterm infants. *Cochrane Database of Systematic Reviews.* https://doi.org/10.1002/14651858.CD012362.pub3

Travers, C. P., Gentle, S., Freeman, A. E., Nichols, K., Shukla, V. V., Purvis, D., Dolma, K., & Winter, L. (2022). A quality improvement bundle to improve outcomes in extremely preterm infants in the first week. *Pediatrics, 149*(2), e2020037341.

Van Beek PE, Groenendaal F, Broeders L, Dijk PH, Dijkman KP, van den Dungen FAM, et al. Survival and causes of death in extremely preterm infants in the netherlands. *Arch Dis Child Fetal Neonatal Ed*. *106*:251–257. 2021.

Vogel, J. P., Chawanpaiboon, S., Moller, A. B., Watananirun, K., Bonet, M., & Lumbiganon, P. (2019). Global, regional, and national estimates of levels of preterm birth in 2014: A systematic review and modelling analysis. *The Lancet Global Health, 7*(1), e37–e46. https://doi.org/10.1016/S2214-109X(18)30451-0.

Wilson D., Kim D., & Breibart S. (2020). Intraventricular hemorrhage and posthemorrhagic ventricular dilation: current approaches to improve outcomes. *Neonatal network Journal, 39*(3), 158-169.

Yue, G., Wang, J., Li, H., Li, B., & Ju, R. (2021). Risk factors of mechanical ventilation in premature infants during hospitalization. *Therapeutics and Clinical Risk Management, 17*, 777–787.