

## Effect of Preventive Care Bundle Guidelines for Nurses on Incidence of Intraventricular Hemorrhage among Mechanically Ventilated Preterm Neonates

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### Abstract

**Background:** Intraventricular hemorrhage (IVH) is a major neurological complication responsible for preterm neonates' morbidity and mortality. In the first 72 hours of life, nurses have a critical role in maintaining bundled practices for intraventricular hemorrhage prevention. **The study aimed** to assess preventive care bundle guidelines for nurses on the incidence of intraventricular hemorrhage among preterm neonates who were mechanically ventilated. **This study was carried out** at Neonatal Intensive Care Unit of Specialized Pediatric Hospital at Benha city. **Sample of the study** was convenient sample for nurses and purposive sample for preterm neonates who consisted of 60 preterm neonates on mechanical ventilation and 60 nurses who cared for them at previous setting. **Tools of data collection** included four tools, (1) A structured Interviewing Questionnaire Sheet, (2) Medical record of preterm neonates, (3) Intraventricular hemorrhage grading scale, (4) preventive care bundle checklist. **The main results of this study** revealed high statistical significant improvement in the studied nurses' total level of knowledge and total practice post- preventive care bundle guidelines implementation. Additionally, there was a negative correlation between total nurses' knowledge, their practice and IVH incidence pre and post-neonatal care bundle guidelines implementation. **The main recommendation** is Conducting an orientation programs for nurses in NICU with regular updates of knowledge and practice regarding preventing intraventricular hemorrhage for enhancing the quality of care and reducing in the incidence of all grades of IVH.

**Keywords:** Intraventricular hemorrhage, Preterm neonates, Preventive care bundle

### Introduction

A preterm is a neonate who 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., 2020).

Mechanical ventilation can trigger many complications especially in preterm neonates such as; bronchopulmonary dysplasia, white matter injury, cerebral inflammation, periventricular leukomalacia and intraventricular hemorrhage (Atienza-Navarro et al., 2020).

Intraventricular hemorrhage is presents a major complication among preterm neonates

especially who are on mechanical ventilation and inversely associated with gestational age and birth weight. It originates from the germinal matrix with an immature capillary bed. Pathophysiology for intraventricular hemorrhage triggered by accumulated blood in the lateral ventricles, which obstructs cerebrospinal fluid circulation (Greenberg, 2020).

Intraventricular hemorrhage (IVH) constitutes a major neurological complication responsible for preterm neonates' morbidity and mortality. There are many factors that contribute to intraventricular hemorrhage development such as; low birth weight , lung immaturity ,low gestational age, and male gender. The other postnatal factors include; respiratory distress with episodes of hypercapnia, hypoxia, hypocapnia and academia. Moreover, mechanical ventilation also related to increased risk of IVH. As both respiratory distress and mechanical ventilation influence and lead to changes in cerebral blood flow and central venous pressure which develop IVH development (Daigneault et al., 2020).

Tracheal intubation interferes with the respiratory secretion clearance which leads to bradycardia, hypoxia and intracranial hypertension. In addition, mechanical ventilation accumulates the positive intra thoracic pressure that can impede venous return and decrease cardiac output consequently (*Lopriore et al., 2020*).

Cranial ultrasound examinations are typically performed in the first week of life to detect IVH, and the images are used to classify IVH according to the algorithm adapted from (Papile et al., 1978) as the following; grade I IVH is limited to the subependymal region; grade II IVH has blood in the ventricles without ventricular distension; and grade III IVH shows enlarged ventricles due to distention. The classic grade IV IVH arises from white matter infraction than extension of the IVH into the parenchyma (*Garfinkle & Miller, 2020*).

Intraventricular hemorrhage can be prevented by the following; firstly, prenatal administration of steroids and maternal transfer to a tertiary level hospital are the best means of preventing IVH. Secondly, excellent perinatal management as; delayed cord clamping, early continuous positive airway pressure, and noninvasive ventilation strategies that may prevent brain injury. Additionally, preventive practice bundles that limit fluctuations in cerebral blood flow via maintenance of partial pressure of carbon dioxide (Pco<sub>2</sub>) and metabolism through maintaining normal range. In addition to, avoiding increased suction, handling, and rapid volume infusions (*Berthaud et al., 2020*).

Preventive care bundle are defined as a combinations of measures have been developed which have shown some promise in preventing IVH. The nurses play an important role in managing interventions that will be beneficial to prevent IVH, particularly in the first 72 hours of life when preterm neonates are most vulnerable. Most IVH preventive care bundles focus on this critical time period. The Key nursing interventions in IVH preventive care bundle include: midline position of head and head of bed elevation, minimal handling, reducing

painful procedures, hemodynamic and respiratory stability (*Garfinkle & Miller, 2020*).

Minimal handling, control of stressful environment and painful procedures, positioning of preterm head midline, elevating the bed head, and maintenance of normothermia have been identified as helpful practices in prevention of IVH. In addition to, the other measures for enhancing auto regulation of cerebral blood flow should be performed by the nurse. Planning targeted goals for oxygen saturation prevent exposure to high oxygen levels because hyperopia is toxic to brain. Moreover, effective protection from noise and light and slow administration of the fluid boluses are frequently included in preventive care bundles. Because of the critical role of nurses who cared with mechanically ventilated preterm neonates, they should have enough knowledge and practices regarding measures of care bundle for prevention of IVH (*Bonifacio & VanMeurs, 2019*).

#### **Significance of the study:**

Preterm neonates' requirement of mechanical ventilation has increased due to low gestational age and the less mature lungs which rise respiratory support demand. In addition to, 60–95% of preterm neonates worldwide require mechanical ventilation after their birth. Although, the brains of them are vulnerable for intraventricular hemorrhage (*Chan et al., 2020*). Despite the technological advancements of neonatology science, IVH continues to take important place as a cause for death of approximately 45 percent of total mortality rate of mechanically ventilated preterm neonates. Moreover, the intraventricular hemorrhage incidence of severe grades has increased particularly in preterm neonates born from 22 to 25 weeks' gestational age (GA) (*Wilson et al., 2020*).

In preterm neonates, intraventricular hemorrhage is found to be predominant during first five days of preterm neonates' life. So, application of bundled practices for preventing intraventricular hemorrhage is recommended during the first 72 hours from preterm neonates birth is acritical role for the nurses (*Daigneault et al., 2020*). Present study aim is to assess preventive care bundle guidelines for nurses on the incidence of intraventricular hemorrhage

among preterm neonates who were mechanically ventilated.

### **Aim of the study**

The study aim is to assess preventive care bundle guidelines for nurses on the incidence of intraventricular hemorrhage among preterm neonates who were mechanically ventilated through:-

- Assessing nurses' knowledge and practice towards prevention of intraventricular hemorrhage among mechanically ventilated preterm neonates
- Designing preventive care bundle guidelines for nurses based on pre-program assessment.
- Implementing and evaluating the effect of preventive care bundle on knowledge of nurses and their practice towards prevention of intraventricular hemorrhage among mechanically ventilated preterm neonates
- Evaluating the effect of the improved nurses' knowledge and practice after application of preventive care bundle guidelines on incidence of intraventricular hemorrhage among mechanically ventilated preterm neonates

### **Research hypotheses:**

- The preventive care bundle guidelines will improve nurses' knowledge and practice towards prevention of intraventricular hemorrhage among mechanically ventilated preterm neonates.
- The improved nurses' knowledge and practice after application of preventive care bundle guidelines will reduce incidence of intraventricular hemorrhage among mechanically ventilated preterm neonates.

### **Subjects and Method**

#### **Research design:**

A quasi experimental design was utilized to achieve the aim of the study.

#### **Research Setting:**

The researchers carried out the study at Neonatal Intensive Care Units (NICU) of Specialized Pediatric Hospital at Benha city which affiliated to Egyptian Ministry of Health and Population.

### **Subjects:**

Data of the present study were gathered from the above mentioned study setting, the sample consisted of:

- 1- A convenience sample of all the available nurses (60) who cared for preterm neonates at previously mentioned setting.
- 2- A purposive sample of Preterm neonates (n=60) who divided to 30 preterm neonates are case and the other 30 are control, throughout pre and post assessment at the previously mentioned setting with certain criteria.

### **Inclusion criteria:**

Preterm neonates who required mechanical ventilation throughout the first 72 hours of birth.

### **Exclusion criteria:**

Preterm neonates who have admitted with

- Cerebral congenital anomalies
- Brain or neck surgery

### **Tools of Data Collection:**

The following four tools were used for data collection:

#### **(1) A structured Interviewing Questionnaire Sheet:**

It was designed by the researchers in the light of relevant studies as books, magazines, articles, journals, and web sites and written in an Arabic language

#### **Part (I): Personal data of nurses:**

It included nurses' personal characteristic such as; age, gender, qualifications, years of experiences and training courses regarding intraventricular hemorrhage in preterm neonates.

#### **Part II: Nurses, knowledge regarding intraventricular hemorrhage in preterm neonates:**

It included the following:

- Preterm neonates such as; definition, causes, complications and nursing care.
- Intraventricular hemorrhage such as; definition, signs and symptoms, grades, causes, and complications.
- Preventive care bundle of Intraventricular hemorrhage among preterm neonates

#### **Scoring system of Nurses' Knowledge:-**

The studied nurses' answers were revised with a model answer, and scored as; don't know had score (0), incomplete correct answer had score (1), and complete correct answer had score (2). The level of nurses' knowledge was categorized as the following:

- Poor knowledge (< 60%)
- Average knowledge (60 % to < 85%).
- Good knowledge ( $\geq 85\%$ ).

**(2) Medical record of preterm neonates:** It was designed by the researchers which included characteristics of preterm neonates. The data obtained from the hospital medical record of preterm neonate. It included; gestational age, gender, weight on admission and current weight, vital signs, mode of ventilation, and laboratory investigations.

**(3) Intraventricular hemorrhage grading scale:**

It was adopted from *Volpe et al., (2017)*. It is grading system for intraventricular hemorrhage which is based on cranial ultrasonography findings. It used to measure the incidence of intraventricular hemorrhage before and after application of the preventive care bundle guidelines as the cranial ultrasound performed within first 72 hours of life and repeated after the first week.

The IVH 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 occurred.

**(4) Preventive care bundle checklist:**

It was adopted by the researchers from *Green N.,(2017)*. It was used for assessing nurses' practice towards prevention of intraventricular hemorrhage among preterm neonates. It included preventive bundle practices such as maintain midline head position, elevate head of bed, maintain normothermia, slow administration of fluid boluses, slow withdrawal of blood samples, respiratory interventions, minimal stimulation and minimize pain and stress.

**Scoring system of preventive care bundle checklist:**

The score of each item of the previous tool was ranged as the following: not done had score (0), incorrectly done had score (1) and correctly done had score (2). According to the nurses' actual practice, their level of practice was categorized as the following:

- Incompetent (< 85%).
- Competent ( $\geq 85\%$ ).

**Tools validity:**

Validity of tools were through three juries in pediatric nursing from the Faculty of Nursing/ Benha University who are experts in the related field and selected to test the content validity of the instruments and to judge its clarity, comprehensiveness, relevance, simplicity, and accuracy. All of their comments were taken into consideration; some items were re-phrased to reach the final version of the tools.

**Reliability assessment:**

The developed and validated tools for knowledge assessment questionnaire, intraventricular hemorrhage grading scale and preventive care bundle checklist were tested for reliability. Test- re-test results using Cronbach's alpha coefficient cleared that all items were significantly differ with a correlation above the threshold of significance ( $r=0.95, 0.86$  &  $0.94$ ) respectively.

**Administrative and Ethical consideration:**

All the relevant principles of ethics in the research were followed. Before starting the practical work, nurses consent to participate was obtained after informing them about their rights to participate or withdraw at any time. Confidentiality of information was ensured.

**Pilot Study:**

A pilot study was carried out on 10% of predetermined sample which accounted as (6) preterm neonates undergoing mechanical ventilation and (6) nurses who cared with them to test clarity, feasibility, and applicability of the study tools, and time needed for each tool to be filled in. Few modifications were done according to the pilot study findings.

**Field of work:**

The process of data collection was carried out from the beginning of December 2019 to the end of March 2020.

**Assessment phase:**

- 1- The researchers were available at each study setting three days weekly (morning & afternoon shifts) for collection of data using study tools.
- 2- Take approval of nurses' participation after clarifying study purpose
- 3- The researchers observed nurses' practice during caring of preterm neonates using the preventive care bundle checklist.
- 4- Questionnaire sheets related to nurses' knowledge assessment have been explained and administered to them.
- 5- The researchers measured incidence of intraventricular hemorrhage using intraventricular hemorrhage grading scale for recording grades of IVH as viewed in cranial ultrasound which performed within the first 72 of life. This period of pretests took 4 weeks.
- 6- The pre-test findings was analyzed to detect the actual needs of nurses' knowledge and practice then, general and specific objectives of preventive care bundle guidelines were stated and implemented to satisfy the nurses' actual needs.

**Implementation of preventive bundle guidelines**

This phase took 8 weeks with fulfillment of ten sessions with continuous motivation and positive reinforcement for participants. Divided to three theoretical sessions and seven practical sessions. Nurses were lectured in small groups in each session with average time 45 minutes for theoretical and 60 minutes for practical sessions.

The theoretical sessions of preventive care bundle guidelines include;

- Preterm neonates.
- Intraventricular hemorrhage
- Preventive care bundle for Intraventricular hemorrhage

The practical sessions of preventive care bundle guidelines include;

- Maintain midline head position
- Elevate head of bed.
- Maintain Normothermia 36.5-37.
- Slow Administration of Fluid Boluses.
- Slow Withdrawal during blood sample taking.
- Minimize Stimulation, pain and Stress.

**Teaching methods and media:**

Different teaching methodologies were used as lectures, group discussion, demonstration and re demonstration. Different illustrated pictures and videos were used in order to facilitate nurses understanding.

**Evaluation phase:**

Posttest was applied for nurses after implementing bundle to assess their knowledge and practice using pretest tools for evaluation of bundle guidelines. This was done immediately after the intervention. This phase took about 4 weeks.

**III. Administrative Design:**

Permission was granted from hospital directors and Head of units at Benha Specialized Pediatric Hospital after clarifying nature and study objectives to get consent for conducting the study.

**IV. Statistical Design:**

After collection of study data, it was organized, categorized, and analyzed, using frequencies, percentage, mean scores, standard deviation, paired t test, Cronba h alpha, chi-square test and correlation test. tables and figures were formed by using SPSS version 20 to present data.

**Result**

**Table (1)** reveals that the mean age of the studied nurses was  $28.83 \pm 6.23$  years. In relation to gender of the studied nurses, the table represents that three quarters (75.0%) of nurses were females. Regarding nurses' educational level, the table clarifies that less than half (45.0%) of them received bachelor of nursing science. As regard to experience years in NICU, it is found that 61.75% of the studied nurses had less than five years of experience.

**Figure (1)** illustrates that majority of the studied nurses didn't have training courses regarding intraventricular hemorrhage in preterm neonates

**Table (2)** reflects that; 60.0% of the studied preterm neonates in the study group had respiratory distress syndrome compared to 66.7% of the control group. Concerning to gestational age, it is noticed that the gestational age 24 <28 weeks in both study and control groups were (53.3%, 46.7%) respectively. As regard the weight, the table indicates that more than half (53.3 % & 56.7%) of preterm neonates in both study and control groups weighted 1000 <1500 grams respectively. Regarding mode of mechanical ventilation, it is found that less than two thirds (60%) of preterm neonates in the study group put on PPV compared to 50 % of the control.

**Figure (2)** shows that 66.7% of the studied preterm neonates were males in the study group compared with more than half (56.7%) of control groups.

It is clear from **table (3)** that about two thirds (66.7%) of studied nurses with poor level of knowledge pre-preventive care bundle guidelines. While, the majority of them (80.0%) had good level of knowledge post- preventive care bundle guidelines, with highly statistical significant improvement in the nurses' level of knowledge post- preventive care bundle guidelines as compared with pre- preventive care bundle guidelines ( $P < 0.000$ ).

**Table (4)** reflects that, there is a highly statistically significant improvement ( $P < 0.000$ ) in mean score of studied nurses' practice post-preventive care bundle guidelines in relation to maintaining midline head position ( $7.016 \pm .747$ ), elevating head of bed ( $5.183 \pm .701$ ), maintaining normothermia 36.5-37 ( $4.733 \pm .578$ ), slow administration of fluid boluses ( $7.66 \pm .572$ ), slow withdrawal flushing of UALCs and PALs ( $1.78 \pm .415$ ), respiratory interventions ( $10.216 \pm 1.415$ ), minimal stimulation ( $17.90 \pm .774$ ) & minimizing pain and stress

( $5.483 \pm .503$ ), when compared with pre-preventive care bundle guidelines.

**Table (5)** This table represents that, more than two thirds of the studied nurses (68.3%) had an unsatisfactory practice score regarding preventive care bundle of IVH pre- neonatal care bundle guidelines. However, the majority of them (81.7%) had a satisfactory practice score post- neonatal care bundle guidelines. Moreover, it's clear from high table that, there is a highly statistical significant improvement in nurses' practice score post- preventive care bundle guidelines as compared with pre-preventive care bundle guidelines ( $P < 0.000$ ).

**Figure (3)** clarifies that less than half (46.7%) of preterm neonates in control group had IVH compare to 33.3 % in study group. Moreover, more than half (53.3%) of them in control group didn't have IVH compared with 66.7% in study group.

**Table (6):** demonstrates that; 50% of the studied preterm neonates had IVH grade IV in control group compared with less than two thirds (60%) had IVH grade III in study group with statistical significant difference ( $P < 0.02$  )

**Table (7)** reflects that, there is a statistical significant relation between characteristics of the studied preterm neonates (diagnosis, gestational age, birth weight & mode of ventilation) and grade of intraventricular hemorrhage in study and control groups ( $P \leq 0.05$ ).

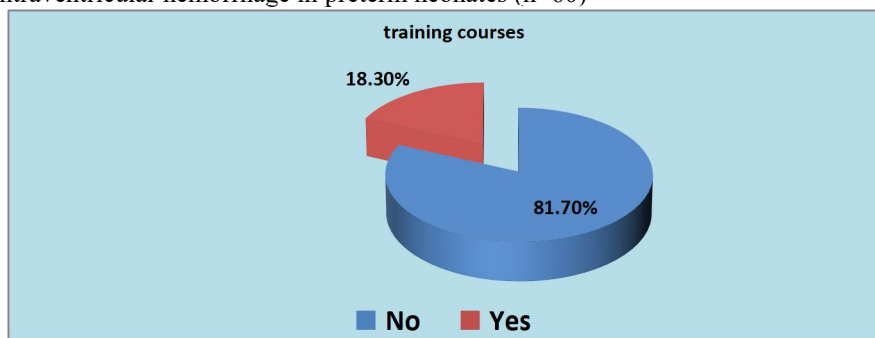
**Table (8)** reveals that, there is a positive correlation between total nurses' knowledge and practice scores pre and post- preventive care bundle guidelines ( $P \leq 0.001$ ).

**Table (9):** shows that, there is a negative correlation between total nurses' knowledge and incidence of IVH pre & post-neonatal care bundle guidelines ( $P < 0.05$  &  $P < 0.001$ ).

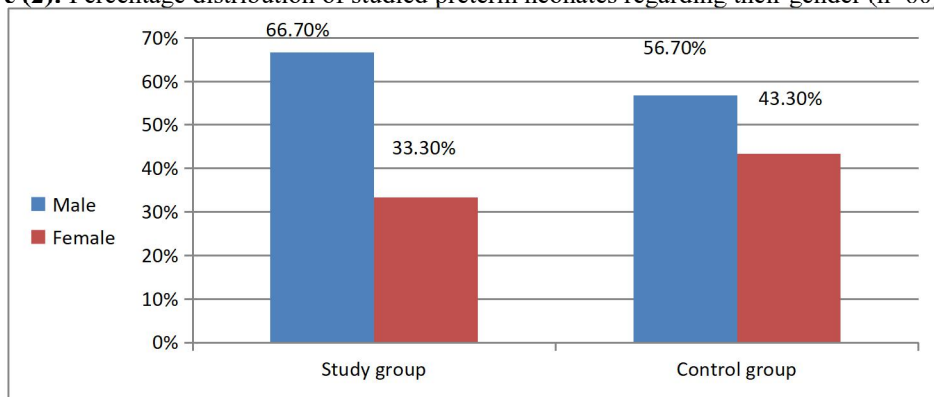
**Table (10):** shows that, there is a negative correlation between total practice of nurses and incidence of IVH pre & post-neonatal care bundle guidelines ( $P < 0.001$ ).

**Part (I): Personal data of nurses:****Table (1):** Percentage distribution of studied nurses regarding their personal data (n=60)

Personal data of the studied nurses	No.	%
<b>Age in years</b>		
< 20	9	15.0
20 < 25	7	11.7
25 < 30	12	20.0
≥ 30	32	53.3
<b>Mean ± SD</b>	<b>28.83±6.23</b>	
<b>Gender</b>		
Male	15	25.0
Female	45	75.0
<b>Educational level</b>		
Diploma	16	26.7
Nursing Technical institute	13	21.7
Bachelor degree in nursing science	27	45.0
Postgraduate studies	4	6.7
<b>Years of experience in NICU</b>		
< 5	37	61.7
5 < 10	10	16.7
≥10	13	21.7
<b>Mean ± SD</b>	<b>5.45±3.83</b>	

**Figure (1):** Percentage distribution of studied nurses according to training courses regarding intraventricular hemorrhage in preterm neonates (n=60)**Table (2):** Percentage distribution of studied preterm neonates according to their characteristics (n=60)

Characteristics of preterm neonates	Study group (n=30)		Control group (n=30)		X2 (P -value)
	No.	%	No.	%	
<b>Diagnosis</b>					
- Respiratory distress syndrome	18	60.0	20	66.7	3.058 (.383)
- Neonatal sepsis	4	13.3	2	6.7	
- Pneumonia	6	20.0	3	10.0	
- Cardiac congenital anomalies	2	6.7	5	16.7	
<b>Gestational age/weeks</b>					
- 24 < 28	16	53.3	14	46.7	.269 (.874)
- 28 < 32	6	20.0	7	23.3	
- 32 ≤ 36	8	26.7	9	30.0	
<b>Mean ± SD</b>	30.06±2.77		30.80±2.65		
<b>Weight/ grams</b>					
- 500 < 1000	5	16.7	3	10.0	.791 (1.041)
- 1000 < 1500	16	53.3	17	56.7	
- 1500 < 2000	5	16.7	4	13.3	
- 2000 ≤ 2500	4	13.3	6	20.0	
<b>Mean ± SD</b>	1276.66±484.00		1443.33±511.03		
<b>Mode of mechanical ventilation</b>					
- PPV	18	60.0	15	50.0	2.406 (.493)
- SIMV	3	10.0	3	16.7	
- CPAP	7	23.3	7	23.3	
- CMV	2	6.7	5	10.0	

**Figure (2):** Percentage distribution of studied preterm neonates regarding their gender (n=60)**Table (3):** Percentage distribution of studied nurses regarding total level scores of knowledge (pre/post- preventive care bundle guidelines) (n=60)

Nurses' total level of knowledge	Pre-neonatal care bundle guidelines		Post-neonatal care bundle guidelines		X <sup>2</sup>	P-value
	No.	%	No.	%		
Poor	40	66.7	3	5.0	68.22	0.000**
Average	15	25.0	9	15.0		
Good	5	8.3	48	80.0		

\*\* (High statistical significant differences P value <0.001)

**Table (4):** Mean score of studied nurses' practice regarding preventive care bundle of IVH (pre/post- preventive care bundle guidelines) (n=60)

Practice items	Pre- preventive care bundle guidelines	Post- preventive care bundle guidelines	t-test	P-value
	Mean ± SD	Mean ± SD		
Maintain midline head position	5.13±.853	7.016±.747	12.213	0.000**
Elevate head of bed	4.06±.756	5.183±.701	11.045	0.000**
Maintain normothermia 36.5-37	4.07±.778	4.733±.578	6.170	0.000**
Slow administration of fluid boluses	6.350±1.375	7.66±.572	7.720	0.000**
Slow withdrawal flushing of UALCs and PALs	1.316±.469	1.78±.415	5.798	0.000**
Respiratory interventions	8.433±1.226	10.216±1.415	10.201	0.000**
Minimal stimulation	16.61±1.165	17.90±.774	10.373	0.000**
Minimize pain and stress	4.966±.843	5.483±.503	5.197	0.000**

\*\* (High statistical significant differences P value <0.001)

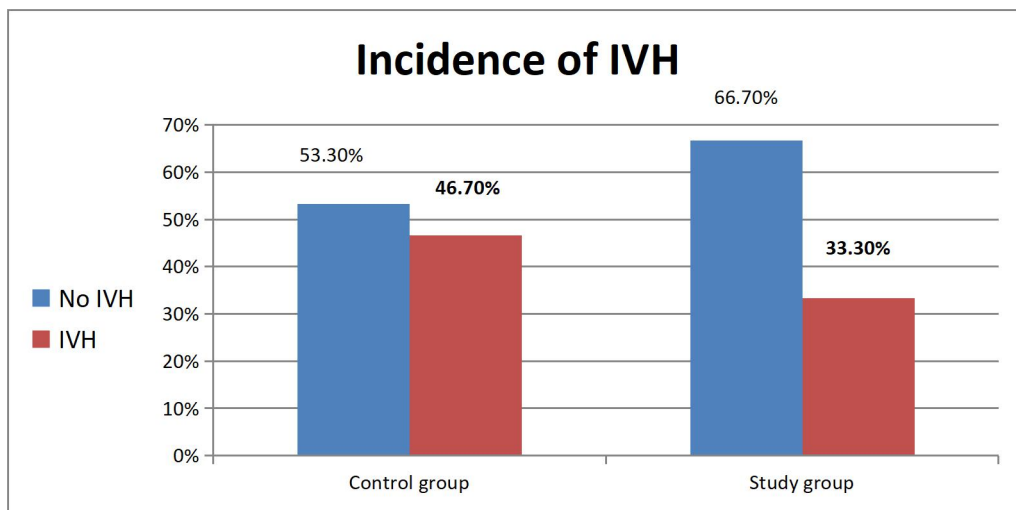
**Table (5):** Distribution of total practice scores of studied nurses regarding preventive care bundle of IVH (pre/post- preventive care bundle guidelines) (n=60)

Nurses' total level of Practice	Pre- preventive care bundle guidelines		Post- preventive care bundle guidelines		X <sup>2</sup>	P-value
	No.	%	No.	%		
Unsatisfactory	41	68.3	11	18.3	30.54	0.000**
Satisfactory	19	31.7	49	81.7		

\*\* (High statistical significant differences P value <0.001)



**Figure (3):** Percentage distribution of the preterm neonates according to incidence of IVH (pre/post-preventive care bundle guidelines) (n=60)



**Table (6):** Percentage distribution of the preterm neonates according to IVH grading scale (pre/post-preventive care bundle guidelines)

Grade of IVH	Control group (n=14)		Study group (n=10)		X2 (P-value)
	No.	%	No.	%	
I	3	21.4	1	10.0	<b>9.60 (0.022)*</b>
II	1	7.1	3	30.0	
III	3	21.4	6	60.0	
IV	7	50.0	0	0.0	

\*\* (High statistical significant differences P-value <0.001) \*(Statistical significant differences P-value <0.05)

**Table (7):** Relation between characteristics of the preterm neonates and grade of intraventricular hemorrhage

Items	Control group (n=14)								X2 (P-value)	Study group (n=10)						X2 (P-value)	
	Grade of IVH									Grade of IVH							
	I		II		III		IV			I		II		III			
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
<b>Diagnosis</b>									12.81								10.00
- Respiratory distress syndrome	1	33.3	0	0.0	2	66.7	6	85.7	(.046)*	0	0.0	1	33.3	5	83.3	10.00 (.04)*	
- Neonatal sepsis	0	0.0	1	100.0	1	33.3	0	0.0		1	100.0	0	0.0	1	16.7		
- Pneumonia	2	66.7	0	0.0	0	0.0	1	14.3		0	0.0	2	66.7	0	0.0		
- Cardiac congenital anomalies	0	0.0	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		
<b>Gestational age/ weeks</b>									16.57								10.00
- 24<28	0	0.0	0	0.0	3	100.0	4	57.1	.011*	0	0.0	2	66.7	4	66.7	10.00 .04*	
- 28<32	0	0.0	0	0.0	0	0.0	3	42.9		0	0.0	1	33.3	2	33.3		
- 32≤36	3	100.0	1	100.0	0	0.0	0	0.0		1	100.0	0	0.0	0	0.0		
<b>Birth weight/grams</b>									18.22								16.25
- 500 <1000	0	0.0	0	0.0	3	100.0	2	28.6	(.033)*	0	0.0	0	0.0	3	50.0	16.25 .012*	
- 1000 <1500	2	66.7	1	100.0	0	0.0	0	0.0		0	0.0	1	33.3	3	50.0		
- 1500 <2000	1	33.3	0	0.0	0	0.0	1	14.3		0	0.0	2	66.7	0	0.0		
- 2000 ≤2500	0	0.0	0	0.0	0	0.0	0	0.0		1	100.0	0	0.0	0	0.0		
<b>Mode of ventilation</b>									13.77								.050*
- PPV	3	100.0	1	100.0	2	66.7	0	0.0	.032*	1	100.0	2	66.7	0	0.0	.050*	
- SIMV	0	0.0	0	0.0	1	33.3	1	14.3		0	0.0	0	0.0	1	16.7		
- CPAP	0	0.0	0	0.0	0	0.0	6	85.7		0	0.0	1	33.3	5	83.3		
- CMV	0	0.0	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		

\*(Statistical significant differences P-value ≤0.05)

**Table (8):** Correlation between total nurses' knowledge and practice scores regarding preventive care bundle of IVH (pre/post-neonatal care bundle guidelines)

Variables	Knowledge (pre- preventive care bundle guidelines)	Practice (post-preventive care bundle guidelines)
	r/P-value	r/P-value
Practice (pre- preventive care bundle guidelines)	.826/.000**	-----
Knowledge (post- preventive care bundle guidelines)	-----	.536/.000**

\*\* (A highly statistically significant difference  $P < 0.001$ ).

**Table (9):** Correlation between total nurses' knowledge and incidence of IVH (pre/post-preventive care bundle guidelines)

Variables	Knowledge (pre-neonatal care bundle guidelines)	Incidence of IVH (post- neonatal care bundle guidelines)
	r/P-value	r/P-value
Incidence of IVH (pre- neonatal care bundle guidelines)	-0.867/.005*	-----
Knowledge (post-neonatal care bundle guidelines)	-----	-0.973/.000**

\* (Statistically significant difference  $P < 0.05$ ). \*\* (High statistical significant differences  $P < 0.001$ )

**Table (10):** Correlation between total nurses' practice and incidence of IVH (pre/post-neonatal care bundle guidelines)

Variables	Practice (pre-neonatal care bundle guidelines)	Incidence of IVH (post- neonatal care bundle guidelines)
	r/P-value	r/P-value
Incidence of IVH (pre- neonatal care bundle guidelines)	-0.794/.000**	-----
Practice (post-neonatal care bundle guidelines)	-----	-0.852/.000**

\*\* (High statistical significant differences  $P < 0.001$ )

## Discussion

Intraventricular hemorrhage (IVH) is a leading mortality risk factor among preterm neonates. Its occurrence is associated with both short-term and long-term complications. These complications include; post-hemorrhagic ventricular dilatation (PHVD), neurodevelopment disabilities, and white matter abnormalities which can lead to cognitive impairment, decreased visual fields, and spastic diplegia. So, early management and prevention of intraventricular hemorrhage is a challenge for nurses cared with preterm neonates especially for those undergoing mechanical ventilation (*McCauley et al., 2020*).

Regarding personal data of the studied nurses; results of the present study clarified that the mean age of the studied nurses was  $28.83 \pm 6.23$  years. This may be due to critical case of the preterm neonate on mechanical ventilation, NICU policy prefer selection nurses in specific age for caring with neonates. These findings are consistent with *Mohamed, (2018)*

who carried out a study to "evaluate quality of nursing care provided for preterm neonates of low birth weight with intraventricular hemorrhage" and found that the mean age of the studied nurses was  $29.45 \pm 9.67$ .

Regarding gender of the studied nurses, the current study indicated that three quarters of the studied nurses were females. This result may be due to the majority of nursing staff were females at previous times. This result agrees with *Elsobkey and Amer, (2018)* who studied "effect of educational guidelines program about nursing care of neonates receiving continuous positive airway pressure" and found that most of the studied nurses were females.

Concerning the educational level, the result of the present study demonstrated that less than half of the studied nurses received bachelor of nursing science. This may be due to nursing facilities now providing the community with large number of graduated nurses. This finding is contradicting with *Alsharkawi et al., (2019)* who conducted "intervention program

for nurses about care of preterm neonates undergoing continuous positive airway pressure" and pointed out that more than half of the studied nurses had nursing technician institute. Furthermore, these finding disagree with *Elsobkey and Amer, (2018)* who mentioned that more than half of the nurses graduated from institute of nursing.

As regard years of experience, the current study result showed that less than two thirds of the studied nurses had less than five years of experience in NICU. This may be due to the changes of staff nurses that occurred in hospital units. This finding is compatible with *Abo-Elezz et al., (2019)* who investigated "effect of guidelines application on nurses knowledge and performance for preventing and management of intraventricular hemorrhage among preterm neonates" and demonstrated that 60.0% of the studied nurses had years of experience ranged from 1<5 years.

Concerning training courses regarding intraventricular hemorrhage in preterm neonates, the study finding revealed that majority of the studied nurses didn't attend training. Similarly, this result is in harmony with *Mohamed, (2018)* who reported that no one of the studied nurses attend training courses regarding caring for preterm neonates on mechanical ventilation and avoiding intraventricular hemorrhage occurrence . Likewise, *Abo-Elezz et al., (2019)* revealed that more than half of the studied nurses did not attend any training courses about care of high risk neonates.

As regards characteristics of studied preterm neonates, the study result reflects that less than two thirds of the studied preterm neonates in the study group had respiratory distress syndrome compared to 66.7% of the control group. This finding is in the same context with *Al-Mauqdad et al., (2020)* who carried out a study to find out "risk factors regarding intraventricular hemorrhage in premature neonates in the central region of Saudi Arabia" and revealed that respiratory distress syndrome is one of the known risk factors for IVH in premature neonates. Additionally, this result is in compliance with *Elsobkey and Amer, (2018)* who showed that

more than half of the studied infants have respiratory distress syndrome.

Concerning to gestational age, it is noticed that (53.3%, 46.7%) of the studied preterm neonates had gestational age between 24 <28 weeks with mean age  $30.06 \pm 2.77$ ,  $30.80 \pm 2.65$  in study and control group respectively. The finding is in harmony with *Wallau et al., (2020)* who evaluated "effect of bundle application on the incidence of peri/intraventricular hemorrhage among preterm infants" and found that the mean gestational age of the studied preterm infants pre and post bundle implementation was  $29.2 \pm 1.8$  and  $29.1 \pm 2.0$  weeks respectively. Similarly, this result is in the same context with *Kumar et al., (2020)* who studied elevated supine midline head position for preventing intraventricular hemorrhage in VLBW and ELBW infants and revealed that mean gestational age of infants were  $28.2 \pm 2.8$  and  $28.2 \pm 2.7$  weeks respectively.

As regard birth weight, the present study result clarified that the mean birth weight in preterm neonates was  $1276.66 \pm 484.00$  and  $1443.33 \pm 511.03$  grams respectively. This finding is in agreement with *Egwu et al., (2019)* who assessed "factors triggered intraventricular hemorrhage among preterm neonates in Aminu Kano Teaching Hospital" and revealed that mean birth weight of the inborn neonates was  $1473 \pm 422$  grams.

Regarding mode of ventilation, it is found that less than two thirds of the studied preterm neonates in the study group put on PPV mode compared to 50 % of the control group. This result is corresponding with *Ozek and Gulcan, (2020)* who studied intraventricular hemorrhage in preterm babies and found that IVH is more common in the presence of mechanical ventilation. *Egwu et al., (2019)* reported that respiratory support (CPAP) was a significant risk factor for IVH.

Concerning gender of studied preterm neonates, the current study demonstrated that male neonates constitute about two thirds and more than half of each neonatal group. These findings agree with *Wallau et al., (2020)* who showed that 59.0% and 45.9% of preterm infants pre and post bundle implementation were males respectively. Moreover, the study

result goes in accordance with *Kumar et al., (2020)* who found that more than half of the preterm infants in study and control groups were males. Likewise, this result is similar with *Elsobkey and Amer, (2018)* who indicated that more than half of studied neonates were males.

In an attempt to assess the studied nurses' total level of knowledge, the results of the current study illustrated that about two thirds of them had poor level of knowledge pre-neonatal care bundle guidelines. While, the majority of them had good level of knowledge post- neonatal care bundle guidelines, with highly statistical significant improvement in the nurses' level of knowledge post- neonatal care bundle guidelines as compared with pre-neonatal care bundle guidelines. The improvement of the studied nurses' level of knowledge indicated to effective implementation of the preventive bundle guidelines. This may be due to the age, readiness and experience of the studied nurses in nursing performance which enhancing their abilities to acquire a critical information regarding preventing intraventricular hemorrhage that help in preterm neonates ' care.

The result of the present study are on the same wavelength with *Abo-Elezz et al., (2019)* who represented that majority of the studied nurses have poor score in all knowledge items which has been improved dramatically immediately post the intervention, with a significant differences between nurses knowledge in the pre, immediately and one month after intervention in all knowledge items.

As regards studied nurses' total practice scores, the study findings approved that more than two thirds of the studied nurses had an unsatisfactory practice score regarding preventive care bundle of IVH pre- neonatal care bundle guidelines. However, the majority of them had a satisfactory practice score post-neonatal care bundle guidelines. Moreover, there is a highly statistical significant improvement in nurses' practice score post-neonatal care bundle guidelines as compared with pre-neonatal care bundle guidelines. This indicated to improvement in nursing practice after implementation the preventive care bundle guidelines which may be due to efficient

application of guidelines in care with preterm neonates and the readiness of the studied nurses to improve their level of practice.

The findings of the present study are supported by *Mohamed, (2018)* who found that overall quality of nursing care provided by studied nurses for preterm infants with intraventricular hemorrhage was around average. Furthermore, these results are compatible with *Abo-Elezz et al., (2019)* who illustrated that about two third 64% of the studied nurses' have good practice regarding care of premature neonates with IVH immediately post the nursing intervention guideline compared to pre the nursing intervention guideline.

Concerning the incidence of IVH, the current study result clarified that less than half of preterm neonates in control group had IVH compare to one third in study group. Moreover, more than half of them in control group didn't have IVH compared with two thirds in study group. This indicated that the intraventricular hemorrhage incidence of studied preterm neonates decreased. These findings are consistent with *(Daigneault et al., 2020)* in a study about "decreasing Progression of Intraventricular Hemorrhage in Premature Infants: using Head Ultrasound Screening" who illustrated that less than one third of studied preterm infants had IVH while three quarters of them didn't have IVH. Moreover, *Alotaibi et al., (2020)* who studied "reduction of severe intraventricular hemorrhage" and found that less than one third of the studied preterm infants had IVH compared with majority of them didn't have IVH. Conversely, these results disagree with *Gross et al., (2020)* who carried out a study to evaluate the effect of a neonatal bundle for preventing of intraventricular hemorrhage and indicated that the rate of IVH was 26.2% before and 27.1% after application the neonatal bundle and it had no impact on IVH in preterm infants

Regarding IVH grades in the preterm neonates the study finding demonstrates that; half of them 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. This finding on the same scope with *Kumar et al., (2020)* who found that higher incidence of severe IVH was in VLBW. 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 severe IVH.

One of the notable findings of current study was reflects a statistical significant relation between characteristics of the studied preterm neonates (diagnosis, gestational age, birth weight & mode of mechanical ventilation) and grade of intraventricular hemorrhage in study and control groups. This result indicated to that the mode of mechanical ventilation, gestational age; respiratory distress syndrome and male gender may be high risk factors for intraventricular hemorrhage.

This study is in concurrence with *Ozek and Gulcan, (2020)* who declared that IVH is associated with gestational age and birth weight inversely and is more common in neonates with respiratory distress. Additionally, these results agree with *Szpecht et al., (2016)* who studied "intraventricular hemorrhage in preterm neonates born before 32 weeks of gestation" and revealed that the risk of IVH stage 3 and 4 was the greater with low gestational age. Also, *Alotaibi et al., (2020)* reflected that the rate of severe IVH was highest in the youngest gestational age, while it was significantly decreased in the older groups. On the same scope, the study is coincided with *Al-Mauqdad et al., (2020)* who illustrated that IVH is the most serious complication of premature deliveries, especially in preterm neonates with birth weight < 1500 grams and gestational age < 32 weeks. *Cross et al., (2020)* added that early intubation and use of neonatal CPAP during the first 72 hours of life increased risk for 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. That

concluded to the improved knowledge and practice may reduce incidence of IVH in preterm neonates.

This finding is in agreement with *Bijl-Marcus et al., (2020)* who conducted a study entitled "neonatal bundles that associated with a lack of the incidence of intraventricular hemorrhage in preterm infants" and mentioned that the application of a bundle of nursing intervention is associated with a lower risk of developing IVH in preterm infants. Also, this study is in compliance with *Ferreira et al., (2020)* who concluded that implementation of bundle related to the decrease in the incidence of IVH and this may contribute to the improvement in care quality. Additionally, *Alotaibi et al., (2020)* clarified that rates of IVH decreases significantly over time during the study period ( $p=0.044$ ). Similarly, these findings go in accordance with *Wallau et al., (2020)* who pointed out that implementation of a bundle of interventions to avoid intraventricular hemorrhage was effective for reducing incidence of IVH in preterm infants ( $p=0.03$ ). Conversely, this study is contradicting with *Gross et al., (2020)* who reported that implementation of care bundle was associated neither with reducing the overall rate of IVH nor with severe IVH.

### Conclusion

**Based on the current study results, it were concluded that:**

- The majority of studied nurses had good level of knowledge, and satisfactory level of practice post- preventive care bundle guidelines implementation with highly statistical significant improvement as compared to Pre- preventive care bundle guidelines implementation. Moreover, there is a positive correlation between total nurses' knowledge and practice scores pre and post-preventive care bundle guidelines. Additionally, there is a negative correlation between nurses' total knowledge, practice and incidence of IVH pre and post-neonatal care bundle guidelines that indicated to the improved nurses' knowledge and practice after implementation of preventive care bundle guidelines reduced the incidence of intraventricular hemorrhage among mechanically ventilated preterm neonates.

### Recommendation

**In view of the findings of the present study, the following recommendations can be suggested:**

- Conducting an orientation programs for nurses in NICU with regular updates of knowledge and practice regarding preventing intraventricular hemorrhage for enhancing the quality of care and reducing in the incidence of all grades of IVH.
- Application of preventive care bundle simulation regarding intraventricular hemorrhage for nursing students.
- Implementation web based programs for nurses regarding prevention of intraventricular hemorrhage and its complications as using information technologies facilitate the learning process which allowing nurses to learn at their own pace and make connections to their own experiences

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