

The Effectiveness of a Nursing Care Bundle in Reducing the Incidence of Intraventricular Hemorrhage (IVH) in Premature Infants: A Retro Prospective Study

Masa Masad

s12457008@stu.najah.edu

Specialized Arab Hospital

Jamal Qaddumi

An-Najah National University

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Abstract

Background

This study aims to investigate the effectiveness of the nursing care bundle in reducing the incidence of Intraventricular hemorrhage among premature infants in Ibn Sina Specialized Hospital.

Methods

In this Retro-prospective study, a total of 126 preterm infants participated, with birth weight less than 1500 g or before 32 weeks of gestation, or both. Sixty-two preterm infants admitted between (January-June, 2025) received standard care, whereas 64 preterm infants in the intervention group admitted between September (2025) to February (2026) received the intraventricular hemorrhage nursing care bundle. The intraventricular hemorrhage checklist consisted of (8) dimensions and sub-dimensions, including patient head, head of bed, normothermia, gentle care, slow administration of fluid boluses, sample withdrawal, respiratory interventions and minimal stimulation, which implemented during the first 72 hours of life. The infants were recruited from the Neonatal Intensive Care Unit at Ibn Sina Specialized Hospital in Jenin, Palestine. The study assessed the presence and severity of intraventricular hemorrhage in both groups using transfontanelle ultrasound reports documented in the infants' medical records.

Results

The finding showed that the intraventricular hemorrhage incidence reduced from 61.3% to 17.2% (adjusted OR = 0.039, 95% CI: 0.008–0.192, $p < 0.001$), with a reduction of 44.1% from baseline, after nursing care bundle implementation in the first 72 hours of life, and show that Apgar score at five minutes, inotropic agent and antenatal steroid administration, were a significant predictors for developing intraventricular hemorrhage among premature infants. On the other hand, gestational age, birth weight, Apgar score at one minute, gender, neonatal transport, mechanical ventilator, umbilical cord blood PH at birth and type of delivery, were not a significant predictor for the occurrence of intraventricular hemorrhage among premature infants.

Conclusions

This study demonstrated that the implementation of nursing care bundle was associated with a significant reduction in the incidence of intraventricular hemorrhage among premature infants after implementation in the first 72 hours of life. This result highlights the crucial role of adopting a structured nursing intervention in improving neonatal outcomes.

Introduction

Background

Intraventricular hemorrhage (IVH) is a serious condition that affects premature infants, leading to lifelong developmental issues (1). According to (2), IVH refers to bleeding within the ventricular system of the brain, a fluid-filled space (ventricles) network, which includes cerebrospinal fluid. IVH is characterized by bleeding in the ventricles (3).

This disease occurs frequently among premature infants (4). To elaborate, it occurs among infants who are born more than ten weeks, i.e., premature infants (5). To be specific, infants weighing less than 1500 gram (g) at birth and before 32 weeks of gestation are at high risk for this type of bleeding (6, 7). Knowing that premature means children born alive before thirty-seven weeks of pregnancy (8). Premature infants are more vulnerable to IVH because their brain blood vessels are very fragile and not yet completely developed (9). Several factors contribute to the etiology of IVH, including disturbance of cerebral blood flow and the fragility of the germinal matrix vasculature (10).

Mitigating IVH can be achieved by implementing a structured nursing care bundle (NCB). Within this context, a nursing care bundle is defined as a structured set of evidence-based interventions that are personalized to enhance patient outcomes when executed together. Although these interventions are readily available, the use of a bundle underscores their collective application for better outcomes (11). Bundles differ from checklists in that bundles constitute best practices designed for a particular situation or condition.

More importantly, using a NCB reduced the incidence of IVH. To support this claim, (11) indicate that using a bundle of nursing interventions is correlated with decreased risk of developing a progressive/new (severe) IVH, mortality, and cystic periventricular leukomalacia among preterm infants. This study investigated the effectiveness of using a nursing care bundle among Palestinian nurses to reduce incidence of IVH in premature infants. This study also focused on 10 factors, namely, gestational age (GA), birth weight (BW), gender, type of delivery, antenatal corticosteroid therapy, use of inotropic agents, neonatal transport, Apgar score, umbilical cord blood PH at birth, and endotracheal intubation within 72 hours of life. The study accounted for these factors to test how they may be related to the occurrence of intraventricular hemorrhage among premature infants and how they can be used to control for confounding in determining the effectiveness of the nursing care bundle. These clinical and demographic variables will be included in the study to help determine whether the observed improvement of IVH following a care bundle can be explained solely by the measures themselves or by the variation in the baseline characteristics.

Additionally, estimating these variables gives an understanding of the respective subsets of preterm babies with a higher likelihood of developing IVH and informs clinical interventions more effectively. The rationale behind carrying out this study and focusing on these variables is attributed to the lack of

studies investigating the nursing bundle in Palestine for reducing IVH among premature infants. Therefore, this study is among the first to address this issues.

Aims of the Study

This study aims to: First, investigate the effectiveness of a nursing care bundle in reducing the incidence of intraventricular hemorrhage among premature infants at Ibn Sina Specialized Hospital (ISH) during the first 72 hours of life. Second, to examine the relationship between selected clinical and demographic factors (gestational age, birth weight, gender, type of delivery, antenatal corticosteroid therapy, use of inotropic agents, neonatal transport, Apgar score, and umbilical cord blood pH at birth) and the occurrence of IVH among premature infants at Ibn Sina Specialized Hospital during the first 72 hours of life. Third, to articulate the difference in the incidence of intraventricular hemorrhage among premature infants before and after the implementation of the nursing care bundle among premature infants at Ibn Sina Specialized Hospital during the first 72 hours of life.

Methods

Study Design

This study used a Retro-prospective design, which is defined as a mixed design using retrospective to look back in the past to analyze risk factor and a prospective to look ahead in the future to measure outcomes (12). This design was selected in particular because the aim of the study was to compare the incidence of IVH before and after bundle implementation, retrospective component provides a baseline data before NCB implementation and prospective component allowed evaluation of the bundle after implementation in the first 72 hours of life. Therefore, this design was the most appropriate for assessing the effectiveness of the intervention. In this study, two groups were identified based on their records, and their outcomes are compared. The first group was the pre-bundle group, which refers to infants who admitted before implementing the IVH care bundle. The second group, i.e., was the post-bundle group, which include infants who admitted after implementing the bundle during the first 72 hours of life. This study was quantitative in nature, which means that the data presented were numerical.

Site and Setting

The study was conducted in the Neonatal Intensive Care Unit (NICU) at Ibn Sina Specialized Hospital in Northern West Bank, Jenin, Palestine. This hospital is located on Haifa Street in Jenin city and is considered a private referral hospital in Jenin city. The NICU consists of 25 nurses and multidisciplinary healthcare team specialized in neonatal care and 34 incubators that are fully equipped for the care of preterm infants, this department provides neonatal care for prematurity and critical ill newborns with respiratory, cardiovascular, neurological, gastrointestinal and metabolic disorders, and other critical

conditions as well as sepsis and neonatal jaundice management. Also, consist of 11 phototherapy device and one intensive incubator. Also provide care for high-risk pregnancies and prematurity.

Sample and Sampling

The participants were included using consecutive sampling, which means selecting the participants who meet specific inclusion criteria within specific time period till the desired sample size are met (13). This type of sample was chosen because it included all eligible premature infants admitted to the NICU during the study period until the desired sample size reached. This sample method minimized selection bias and ensure that the sample was representative of the target population available in the study setting. The sample before implementing these bundles during the period from (January to June) 2025, and the sample after implementation includes all admissions of infants during period from (September 2025) to (February 2026), who meet the specified criteria, i.e., infants whose birth weight less than 1500 grams, or who born before completing the 32nd week of pregnancy or both, are eligible for inclusion in this study, the total sample was 126 (pre bundle n = 62) and (post bundle n = 64). The inclusion will further encompass infants who are admitted to NICU within the first 72 hours of life.

However, the infants with complex congenital malformation (cardiac, renal, neurological) were excluded. The premature infants were admitted to the hospital within a particular timeframe before and after the intervention. Premature infants (e.g., GA < 32 weeks and/or BW < 1500g) admitted to the NICU within a specified timeframe (before and after intervention).

Intervention IVH Checklist

The researcher manually abstracted the medical record data from the hospital's medical records. The intervention of this study was a nursing care bundle that was applied in July, 2025. The intervention lasted for 72 hours to investigate if the preterm has IVH or not.

The IVH checklist in this study measures the gestational age for infants who are born before 32 completed weeks of pregnancy. It further indicates a very low birth weight with a birth weight of less than 1500 grams. It also measures the first three days after birth, which is a critical period for intervention and monitoring in preterm infants. It is adopted from (14) and the Ministry of Health, Directorate General of Khoula Hospital (2022) studies.

It consists of (8) dimensions, namely, (1) patient head, (2) head of bed, (3) normothermia, (4) gentle care, (5) slow administration of fluid boluses, (6) sample withdrawal, (7) respiratory interventions, and (8) minimal stimulations. Each dimension consists of several sub-dimensions, are presented in Table 1. [Table 1 about hear]

Table 1
The Dimensions and Sub-Dimensions of IVH Checklist

Dimensions	Sub-Dimensions
Patient Head	Midline positioning during handling and procedures
	Avoid prone positioning
	Log roll to avoid twisting of neck and head.
Head of Bed	Head of Bed not more than 30° (15–30 degrees)
	Complete x-rays with the head of the bed elevated.
	Legs below the head level during diaper change
	X-ray completion is a 2-person procedure.
Normothermia	Servo mode 36.5–37 (no Axillary Temperature)
	Humidity as per policy
Gentle Care	Cluster cares Q6 Hrs.
	2 people to transfer infant, weigh and change sheet
	No routine fontanel assessments
	No routine abdominal girth
Slow Administration of Fluid Boluses	Boluses over 30–60
	mins (except in resuscitation)
	D/W10% bolus over 5 min
	Avoid NaHCO ₃
	Mean BP in normal range.
Sample Withdrawal	Slow withdrawal and flushing over 30 sec/ml
	Avoid frequent sampling
Respiratory Interventions	Avoid prolonged suction
	Avoid routine suctioning
	Stabilize before administering surfactant.
	Avoid hyper/hypocapnia.
	Target (pH 7.20–7.40, PaCO ₂ 40–50)
	Maintain target SpO ₂
	Prevent abrupt hemodynamic alterations.

Dimensions	Sub-Dimensions
Minimal Stimulation	Reduce environmental noise
	Respond to alarms immediately.
	Minimize light (flash phototherapy)
	Avoid changing the bed linens for the first 72 hours.
	Avoid early PICC and lumbar puncture.
	Weight D1 then not for 72 hours (unless medically required)
	Use a large incubator cove.
	Ensure correct alarm settings.
	Minimal handling 10–12 Hrs.

In the IVH checklist, three days refer to the first three calendar days of the infant's life. To elaborate, day 1 means the first (24) hours after birth, day 2 means the second (24) hours of life (24–48) hours, and day 3 means the third (24) hours after birth (48 – 72) hours. These days are the critical initial 72 hours during which low birth weight and very preterm are at their highest risk for IVH. The checklist aims to guarantee strict compliance with preventive practices sought to minimize head movement, physiological stress, and abrupt respiratory or hemodynamic changes.

This NCB was implemented by nursing staff in NICU at ISH, after making a hospital policy that conducted by the researcher in consultation with the head nurse in NICU, and prior to educational sessions that guided by the researcher as an NICU senior nurse, to ensure that nurses understood the NCB component and ensure proper implementation, and adherence to the NCB was assessed daily in nursing routine rounds.

Each day is classified into three categories, namely A, B, and C, which typically denote distinct assessment shifts or times within each day, as illustrated below:

A = Morning Shift (e.g., 7 AM – 3 PM)

B = Evening Shift (e.g., 3 PM – 11 PM)

C = Night Shift (e.g., 11 PM – 7 AM)

Data Collection Tool

The construction of the study tool, in this case, refers to the development and design of the data abstraction sheet used to gather information from patients' medical records. The sheet used in this study for the purpose of data collection was created by the researcher based on a literature review. This sheet has relevant data for the study on the incidence of Intraventricular Hemorrhage.

The extraction sheet includes various sections, including:

- **Section one:** demographic and neonatal characteristics (gender, admission date, group pre/post bundle, in-born/out-born, gestational age, birth weight, type of delivery).
- **Section two:** perinatal risk factors (antenatal corticosteroids, maternal complications, Apgar score 1 min/5 min, umbilical cord blood pH, neonatal transport – where and duration).
- **Section three:** procedures in the first 72 hours (mechanical ventilation (MV) – mode, duration; surfactant administration – time after birth; inotropic agent – type/dose; fluid bolus – volume/frequency; sodium bicarbonate given – dose/indication; hypothermia episodes; hypotension episodes).
- **Section four:** IVH nursing bundle compliance in the first 72 hours.
- **Section five:** Transfontanelle Ultrasound (TFU) results.

Validity and Reliability

In order to assess the validity of the study, a bias-free importation of the data collection instrument, the IVH checklist, was utilized by adopting the validated protocols to provide data within clinical studies by Yong and Shanmugam (2023) and the Directorate General of Khoula Hospital (2022). It has been well realized that this checklist is clinically applicable regarding preventing the risk of IVH among preterm infants. The content validity was enhanced via face validity, by three neonatal care professionals, including the Head Nurse of the NICU and the Head of the Pediatrics department and a neonatal care specialist (NICU Specialist). Assessed the checklist to ensure that it depicts the dimensions that are essential in preventing intraventricular hemorrhage. Moreover, the fact that objective and standardized outcome measures are utilized puts a further streak to the construct validity of the findings, i.e., the Papile grading system used in diagnosing IVH.

The data extraction sheet was developed based on a literature review and assessed by face validity by neonatal care experts.

The measures of internal consistency, such as Cronbach's alpha, were not calculated, because this instrument function as a clinical practice checklist. However, consistency in the implementation of the checklist was maintained through the use of standardized evidence-based nursing practice.

Data Collection Procedure

After taking an ethical approval from Institutional Review Board (IRP) and hospital administrators before commencing data collection. Data collected by the researcher by using data abstract sheet for both groups specifically designed by the investigator after a thorough review of the existing literature (Pre and Post bundle implementation) from the patient medical records.

The pre-bundle group received standard care without the systematic nursing care bundle, while the post-bundle group was exposed to the nursing care bundle. The outcomes of both groups were tracked and compared to evaluate the effectiveness of the bundle in reducing the incidence of IVH. The data for both groups were collected by the researcher from neonatal medical records by using a data extraction sheet form that encompasses variables, like as gestational age, birth weight, IVH diagnosis, and exposure to the care bundle.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and the research ethics committee of the Nursing College at An-Najah National University (Ethical Approval No.: Nurs. Sep. 2025/20).

This research complies with the ethics of conducting research activities with human subjects, including a vulnerable population like neonates. The IRB and Ethics Committee of the Ibn Sina Specialized Hospital was asked to give ethical permission to participate in the study before the actual collection of data. Because of the retro prospective character of the study, informed consent of individual parents or guardians will not be required, but the strict policy of confidentiality and protection of the research data will be complied with during the research itself. In the research, the researcher will be careful not to anonymous the information they extract from the medical records in order to avoid the identification of the infants. The information will be stored respectfully and accessed only by qualified members of the research team. Moreover, the data will be used only academically and scientifically. The research would also follow up on the ethical policy of conducting medical research involving human beings as set in the Declaration of Helsinki.

Neuroimaging

The presence and severity of intraventricular hemorrhage in both groups was assessed through transfontanelle ultrasound reports documented in the infants' medical records. We take the initial TFU that done at day three of life according to our hospital protocol. These ultrasound findings were categorized using the Papile grading system (Grade I–IV) and statistically analyzed to compare IVH incidence between the pre-bundle and post-bundle groups.

The research was determined the existence and severity of IVH in both belts based on transfontanelle ultrasound reports recorded in the medical report of the infants. The ultrasound findings will be divided into four grades in the Papile grading system (Grade I-IV) as mentioned below:

- **Grade I:** Germinal matrix: related bleeding (sensitive region around ventricles).
- **Grade II:** Bleeding expands into the ventricles but without causing dilation.

- **Grade III:** Bleeding into the ventricles with associated ventricular dilation because of the accumulation of blood.
- **Grade IV:** Bleeding expands beyond the ventricles into the surrounding brain tissue (parenchymal hemorrhage), confirming periventricular hemorrhagic infarction.

Statistical Analysis

The statistical analysis of the data was performed to compare the incidence of IVH between the pre- and post-bundle groups. There will be four statistical tests using statistical Package for Social Science (SPSS) version 23. The normality of data distribution was tested using Kolmogorov test so data showed normal distribution. First, descriptive statistics were used to provide a summary of the clinical and demographic variables, such as grades of IVH, gestational age, and birth weight. Second, the Chi-square test was used to compare the incidence of IVH (yes/no) between the groups. Third, an Independent Samples t-test was used to compare continuous variables like gestational age or birth weight, depending on the data distribution between the two groups. Fourth, logistic regression was used to identify the adjusted odds of developing IVH post-care bundle implementation to control potential confounders, such as type of delivery, gestational age, and birth weight.

Results

This chapter the researcher discusses the result of the study to evaluate the effectiveness of the nursing care bundle in reducing the incidence of intraventricular hemorrhage among premature infants. A comparative analysis was performed to assess the difference between both groups, Pre-bundle group (n = 62), post-bundle group (n = 64), answering research questions and testing research hypothesis. A P-Value less than 0.05 is considered statistically significant.

Demographic and neonatal characteristics

One hundred and twenty-six premature infants have participated in the current study: the pre-bundle group (n = 62), and the post-bundle group (n = 64). Table 2 presents the demographic and neonatal characteristic for pre-bundle and post-bundle groups, regarding the place of birth, the proportion of inborn premature infants was higher in the post bundle group (81.3%). According to gender distribution, the majority of premature infants were females, which accounted for 38 in the pre-bundle group. Regarding the type of delivery, caesarean section was considered the predominant method for pre-bundle and post-bundle groups (90.3%, 92.9%, respectively). These findings indicate that the pre bundle and post bundle groups were comparable according to their baseline demographic characteristics.

Table 2
Demographic and neonatal characteristics

Variable	Outcome	Pre-Bundle n (%)	Post-Bundle n (%)	Total n (%)	X2	p. value
Place of birth	In-born	44 (71.0%)	52 (81.3%)	96 (76.2%)	1.835	0.175
	Out-born	18 (29.0%)	12 (18.8%)	30 (23.8%)		
Gender	Male	24 (38.7%)	31 (48.4%)	55 (43.7%)	1.212	0.271
	Female	38 (61.3%)	33 (51.6%)	71 (56.3%)		
Mode of delivery	NVD	6 (9.7%)	5 (7.8%)	11 (8.7%)	0.137	0.711
	C/S	56 (90.3%)	59 (92.2%)	115 (91.3%)		
Note. NVD = Normal Vaginal Delivery; C/S = Caesarean Section.						

Procedures in the first 72 hour

This current study studied the procedures that performed in the first 72 hour of life. Table 3 presents the procedures in the first 72 hours.

Table 3
Procedures in the first 72 hours.

Variable	Outcome	Pre-Bundle n (%)	Post-Bundle n (%)	Total n (%)	X2	p. value
Mechanical Ventilator	No	16 (25.8%)	15 (23.4%)	31 (24.6%)	0.095	0.758
	Yes	46 (74.2%)	49 (76.6%)	95 (75.4%)		
Ventilation mode	no MV	16 (25.8%)	15 (23.4%)	31 (24.6%)	6.008	0.139
	SIMV mode	42 (67.7%)	43 (67.2%)	85 (67.5%)		
	HFO mode	2 (3.2%)	0 (0.0%)	2 (1.6%)		
	SIMV + HFO mode	1 (1.6%)	6 (9.4%)	7 (5.6%)		
	SIMV+CPONT mode	1 (1.6%)	0 (0.0)	1 (0.8%)		
Surfactant administration	No	16 (25.8%)	16 (25.0%)	32 (25.4%)	0.011	0.917
	Yes	46 (74.2%)	48 (75.0%)	94 (74.6%)		
Inotropic agent	No	56 (90.3%)	59 (92.2%)	115 (91.3%)	0.137	0.711
	Yes	6 (9.7%)	5 (7.8%)	11 (8.7%)		
fluid bolus	No	48 (77.4%)	46 (71.9%)	94 (74.6%)	0.511	0.475
	Yes	14 (22.6%)	18 (28.1%)	32 (25.4%)		
NaHCO3 administration	No	62 (100.0%)	62 (96.9%)	124 (98.4%)		0.496
	Yes	0 (0.0%)	2 (3.1%)	2 (1.6%)		
Hypothermia episode	No	62 (100.0%)	63 (98.4%)	125 (99.2%)		1.000
	Yes	0 (0.0%)	1 (1.6%)	1 (0.8%)		

Note. NaHCO3 administration = Sodium Bicarbonate administration; SIMV mode = Synchronized Intermittent Mandatory Ventilation; HFO mode = High Frequency oscillation mode; SPONT mode = Spontaneous mode.

Variable	Outcome	Pre-Bundle n (%)	Post-Bundle n (%)	Total n (%)	X2	p. value
Hypotension episode	No	56 (90.3%)	59 (92.2%)	115 (91.3%)	0.137	0.711
	Yes	6 (9.7%)	5 (7.8%)	11 (8.7%)		
Note. NaHCO3 administration = Sodium Bicarbonate administration; SIMV mode = Synchronized Intermittent Mandatory Ventilation; HFO mode = High Frequency oscillation mode; SPONT mode = Spontaneous mode.						

Comparison of baseline neonatal characteristics between pre-bundle and post-bundle groups.

Table 4 demonstrates the difference in the neonatal baseline characteristics between pre-bundle and post-bundle groups, include gestational age, birth weight, umbilical cord blood PH at birth, Apgar score at 1 and 5 minutes, and the last one, surfactant dose administration.

This study shows that gestational age shows significant difference between pre-bundle and post-bundle groups ($p = 0.001$). On the other hand, birth weight, umbilical cord blood PH, Apgar score at one and five minutes, surfactant number of doses were not significantly different ($p = 0.141, 0.387, 0.685, 0.995, 0.611$ respectively) between pre-bundle and post-bundle groups.

Table 4
baseline neonatal characteristics between pre-bundle and post-bundle groups.

Variable	Group	N	SD	T	p. value
Gestational Age	Pre-Bundle	55	1.324	3.370	0.001
	Post	53	1.956		
	Bundle				
Birth Weight	Pre-Bundle	41	202.5	1.484	0.141
	Post	53	224.7		
	Bundle				
Umbilical cord blood PH	Pre-Bundle	60	0.1191	0.868	0.387
	Post	64	0.9174		
	Bundle				
Apgar score at 1 min	Pre-Bundle	62	1.857	- 0.406	0.685
	Post	64	1.736		
	Bundle				
Apgar score at 5 min	Pre-Bundle	64	1.955	- 0.006	0.995
	Post	62	1.661		
	Bundle				
Surfactant number of doses	Pre-Bundle	62	0.804	- 0.510	0.611
	Post	64	0.846		
	Bundle				

Transfontanelle Ultrasound Result

Table 5 shows the transfontanelle ultrasound result, Papile grading and laterality. We noticed that IVH percentage decreased from (61.3%) in pre bundle group to (17.2%) in post bundle group, and there were statistically significant differences between pre-bundle and post-bundle groups ($p < 0.001$).

According to Papile grading, grade one IVH decreased from (40.3%) to (9.4%), grade 2 IVH decreased from (11.3%) to (4.7%), grade 3 IVH decreased from (1.6%) to zero, in addition grade 4 IVH decreased from (4.8%) to (1.6%), there were statistically significant differences between pre-bundle and post-bundle groups ($p < 0.001$).

According to IVH laterality, we noticed that the left side IVH decreased from (11.3%) to (6.3%), right side IVH decreased from (11.3%) to (4.7%), and bilateral IVH decreased from (38.7%) to (6.3%), there were statistically significant differences between pre-bundle and post-bundle groups ($p < 0.001$).

Table 5
Transfontanelle Ultrasound Result

Variable	Outcome	Pre-Bundle n (%)	Post-Bundle n (%)	Total n (%)	X2	p. value
IVH Present	No	24 (38.7%)	53 (82.8%)	77 (61.1%)	25.774	< 0.001
	Yes	38 (61.3%)	11 (17.2%)	49 (38.9%)		
Papile Grade	no IVH	24 (38.7%)	53 (82.8%)	77 (61.1%)	26.902	< 0.001
	grade 1	26 (40.3%)	7 (9.4%)	33 (24.6%)		
	grade 2	8 (11.3%)	3 (4.7%)	11 (7.9%)		
	grade 3	1 (1.6%)	0 (0.0%)	1 (0.8%)		
	grade 4	3 (4.8%)	1 (1.6%)	4 (3.2%)		
IVH Laterality	no IVH	24 (38.7%)	53 (82.8%)	77 (61.1%)	28.530	< 0.001
	left side	7 (11.3%)	4 (6.3%)	11 (8.7%)		
	right side	7 (11.3%)	3 (4.7%)	10 (7.9%)		
	Bilateral	24 (38.7%)	4 (6.3%)	28 (22.2%)		
Note. IVH = Intraventricular hemorrhage.						

Risk Factors of Intraventricular Hemorrhage

Table 6 demonstrates the results of the logistic regression analysis investigating significant risk factors to developing IVH in premature infants. The analysis of this study shows that the group (adjusted OR = 0.039, $p < 0.001$), Apgar score at 5 minutes (adjusted OR = 0.366, $p = 0.033$), inotropic agent (adjusted OR = 104.5, $p = 0.008$) and antenatal steroid administration (adjusted OR = 0.137, $p = 0.044$), were statistically significant differences associated with IVH occurrence after nursing care bundle implementation, were consider as a significant risk factors for occurrence of IVH.

On the other hand, gestational age (adjusted OR = 1.277, p = 0.231), gender (adjusted OR = 0.434, p = 0.228), type of delivery (adjusted OR = 0.744, p = 0.749), birth weight (adjusted OR = 0.999, p = 0.487), Apgar score at one minute (adjusted OR = 2.669, p = 0.054), neonatal transport (adjusted OR = 1.190, p = 0.824), mechanical ventilation (adjusted OR = 5.557, p = 0.065), umbilical cord blood PH at birth (adjusted OR = 0.036, p = 0.423), were not statistically significant differences associated with IVH after nursing care bundle implementation were consider not a significant predictor for occurrence of IVH.

Table 6
Risk factors of IVH development

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Group	-3.252	0.817	15.828	1	0.000	0.039	0.008	0.192
GA	0.245	0.204	1.437	1	0.231	1.277	0.856	1.905
Gender	– .835	0.692	1.454	1	0.228	0.434	0.112	1.685
Mode of delivery	-0.296	0.635	0.219	1	0.749	0.744	0.214	2.583
BW	-0.001	0.002	0.482	1	0.487	0.999	0.996	1.002
Apgar score at 1 min	0.982	0.509	3.712	1	0.054	2.669	0.983	7.243
Apgar score at 5 min	-1.006	0.471	4.552	1	0.033	0.366	0.145	0.921
Neonatal Transport	0.174	0.778	0.050	1	0.824	1.190	0.259	5.469
MV	1.715	0.929	3.406	1	0.065	5.557	0.899	34.345
Inotropic agent	4.649	1.750	7.061	1	0.008	104.5	3.387	3224
Antenatal steroid	-1.985	0.985	4.061	1	0.044	0.137	0.020	0.947
Umbilical cord blood PH	-3.335	4.164	0.641	1	0.423	0.036	000	124.7

Note. GA = Gestational Age; BW = Birth Weight; MV = Mechanical Ventilator.

Discussion

The aim of this study was to assess the effectiveness of a nursing care bundle in reducing the incidence of intraventricular hemorrhage in premature infants (GA < 32 weeks or/and BW < 1500 grams) at Ibn Sena Specialized Hospital.

Decrease the incidence of IVH following nursing care bundle implementation.

The main finding of this study was the decrease in the incidence of intraventricular hemorrhage among premature infant after nursing care bundle implementation. The incidence of intraventricular hemorrhage following nursing care bundle implementation was 17.2% with a reduction 44.1% from the baseline. This

reduction may be due to the implementing of nursing care bundle that focuses on the maintenance of cerebral blood flow stability and prevent fluctuation, minimizing unnecessary handling, decrease environment stimulation, gentle respiratory intervention, and ensuring appropriate head positioning and head of incubator elevation during the first 72 hours of neonatal period (15), and show a good nursing compliance to NCB.

This nursing care bundle significantly helps in reducing cerebral blood flow fluctuation that considered the main mechanism for the occurrence of IVH among premature infants (16). The finding of current study demonstrate the effectiveness of nursing care bundle implementation in reducing the incidence of intraventricular hemorrhage among premature infants, the reduction following implementation decrease from 61.3% to 17.2% and reduced in sever intraventricular hemorrhage (SIVH) incidence (grade 3 from 1.6% to 0% and grade 4 from 4.8% to 1.6%), and this reduction may be related to nursing care bundle implementation, this support (17) study who found that NCB implementation in very low birth weight (VLBW) infant (BW < 1500 gram) show a significant reduction in SIVH from 4.4% to 1.9% with reduction 57% from baseline, and decline in mortality rate (5.4% to 3%), this highlight the effectiveness of NCB composed from patient head midline positioning, normothermia, gentile care, slow administration of fluid bolus, slow sample withdrawal, minimal stimulation, gentile respiratory intervention, which show the crucial role in reducing or prevent of IVH occurrence among premature infant (18).

Likewise, the current study's findings are consistent with the (19) study, which shows a reduction in the incidence of IVH from 9.8% to 2.4% with a 76% relative reduction from baseline. As well as, this study finding is consistent with (20) study, who found that a decrease in the incidence of IVH among premature infant after implementation in the first 72 hour of life was 41% to 24%, and decrease in severity of IVH (grade 3 and 4) from 18% to 7%. Moreover, the finding of the current study show agreement with (10) study in the United Arab Emirates, who reported that the reduction in the incidence of IVH decreased from 19% to 6% following the implementation of nursing care bundle.

On the other hand, this study finding inconsistent with (21) study in single centre at Mount Sinia Hospital, who found that there was no significant difference in the incidence of IVH after bundle implementation (6.9% vs. 9.8%, $p = 0.370$), in the post bundle group mean GA was 26.8 and mean of BW was 914 and its lower than the pre bundle group (27.3, 1005 respectively), the mean of gestational age in the current study was (30.5 ± 1.324) for the pre-bundle group and (29.4 ± 1.936) for the post bundle group, and the mean of birth weight in current study was (1280.6 ± 202.5) for the pre-bundle group and (1243.1 ± 224.7) for the post bundle group, and it's higher than mean of GA and BW in (21) study and may be related to difference in population characteristics and clinical practice, which may explain why the post bundle group are more vulnerable to developed IVH.

The finding of this study shows the effectiveness of NCB in reducing the severity of IVH among premature infant (grade 3 from 1.6% to 0% and grade 4 from 4.8% to 1.6%), which support the (17) study finding that SIVH reduced from 4.4% to 1.9%, the similarity between this study and the finding of the previous study may be related to the implementation of the nursing care bundle in the first 72 hour in the

neonatal period, this NCB reducing the fluctuation in cerebral blood flow that considered the first mechanism of intraventricular hemorrhage among premature infant (16).

Baseline neonatal characteristics between pre-bundle and post-bundle groups.

The current study assesses several demographic variables between pre-bundle and post-bundle groups to make a comparison of baseline neonatal characteristics between pre-bundle and post-bundle groups, like gestational age, birth weight, umbilical cord blood PH at birth, Apgar score at one and five minutes, and surfactant dose administration.

This study shows that birth weight, umbilical cord blood PH, Apgar score at one and five minutes, surfactant doses administration were not significantly differences ($p = 0.141, 0.387, 0.685, 0.995, 0.611$ respectively) between pre-bundle and post-bundle groups, which is consistent with (18) study finding that show no baseline differences between pre-bundle and post-bundle groups according to birth weight, umbilical cord blood PH, Apgar score at one minutes ($p = 0.23, 0.590, 0.470$ respectively). Moreover, surfactant administration shows agreement with (22) study which found no baseline differences for pre-bundle and post-bundle groups ($p = 0.781$).

While the Apgar score at five minutes shows a contradiction with (18) study finding that found baseline differences for pre-bundle and post-bundle groups ($p < 0.001$) according to Apgar score at five minutes, this finding may be attributed to difference in clinical practice and neonatal care protocol. Which means that pre-bundle and post-bundle groups were homogeneous and can be comparable in baseline according to these factors.

On the other hand, gestational age shows a significant difference between pre-bundle and post-bundle groups ($p = 0.001$) which is inconsistent with (22) study findings, which show that pre-bundle and post-bundle groups illustration similarity in baseline according to gestational age ($p = 0.762$), and thus may be related to difference in gestational age thresholds and population characteristic. Gestational age in this study may be considered as a potential confounder; this was controlled statistically using adjusted logistic regression test, which revealed a non-significant relation between the gestational age and the development of intraventricular hemorrhage, thus pre-bundle and post-bundle groups were homogeneous and can be comparable in baseline according to these factors.

The similarity between pre-bundle group and post-bundle group in neonatal baseline characteristic support that the reduction in intraventricular hemorrhage was related to nursing care bundle implementation.

Risk factors of intraventricular hemorrhage occurrence.

In this study, logistic regression test shows several risk factors for IVH occurrence, to test the association between these factors and the occurrence of intraventricular hemorrhage among premature infants, these factors include (group, gestational age, gender, type of delivery, birth weight, Apgar score

at one and five minutes, neonatal transport, inotropic agent, mechanical ventilator, antenatal steroid administration, umbilical cord blood PH at birth).

This study shows that implementation of a nursing care bundle was significantly reduce the incidence of intraventricular hemorrhage among premature infant (adjusted OR = 0.039, $p < 0.001$), the percentage of IVH among premature infants following nursing care bundle implementation decrease from 61.3% to 17.2% that show agreement with (19) study finding the IVH incidence decrease from 9.8% to 2.4% with a 76% relative reduction from baseline, and show importance of nursing care bundle in reducing the incidence of intraventricular hemorrhage among premature infant, this finding shows the importance of adopting a nursing care bundle in decrease IVH incidence, that can improve neonatal outcome, decrease mortality rate and decrease complication (20).

Furthermore, the Apgar score at five minutes in the present study was found to be as a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 0.366, $p = 0.033$) which is consistent with (23) study, who found that the premature infants with an Apgar score less than 6 at five minutes, are more likely to develop IVH than other babies. This finding may be attributed to the physiological instability in the early neonatal period; the premature infant with lower Apgar score is more likely to develop IVH than others (24).

Additionally, inotropic agent administration in this study found to be a significant risk factor of intraventricular hemorrhage development (adjusted OR = 104.5, $p = 0.008$), which is consistent with (25) study finding that premature infants who require inotropic agent administration are more likely to develop IVH than others. The premature infant who requires an inotropic agent, such as cardiovascular medication support, usually has unstable hemodynamic parameters, which can lead to cerebral blood flow fluctuation and immaturity of cerebral autoregulation and can participate in IVH development (26).

Also, antenatal steroid administration in this study found to be as a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 0.137, $p = 0.044$), which reflect that maternal antenatal steroid administration was a significant intervention for reducing intraventricular hemorrhage among premature infant, which show agreement with (9) study, who found the effectiveness of antenatal steroid administration in infant lung maturation and prevent neonatal respiratory distress syndrome (RDS), and can prevent or reduce early intraventricular hemorrhage because it affect fetal vasoconstriction and reduce fetal vasodilation, which can reduce the cerebral blood flow fluctuation in early neonatal period which consider the main mechanism of IVH (27).

On the other hand, gestational age in this study was not a significant risk factor of intraventricular hemorrhage occurrence (adjusted OR = 1.277, $p = 0.231$), which is inconsistent with (19) study finding that the gestational age is a significant predictor for intraventricular hemorrhage development and infant with lower gestational age (GA < 32 weeks) was more vulnerable to developed IVH than others. This finding may be related to difference in population characteristic, and mean gestational age in the current study was (30.5 ± 1.324) for the pre-bundle group and (29.4 ± 1.936) for the post bundle group, which is higher than the mean gestational age in (19) study (28, 26, respectively), and this explains why

gestational age in the current study was not a risk factor for IVH, and this finding may be related to adopting of nursing care bundle.

In addition, birth weight was not a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 0.999, $p = 0.487$), which mean that no association between low birth weight and the occurrence of intraventricular hemorrhage, and this is contradicts with (19) study finding that birth weight less than 1500 g considered as risk factors for occurrence of IVH among premature infant, very low birth weight (VLBW) infant are vulnerable for developing IVH due to immaturity of cerebral vasculature and germinal matrix fragility, which can lead to increase the risk for developing IVH in early neonatal period (28), this finding may be attributed to difference in population characteristic and neonatal care services, also, the mean birth weight in current study was (1280.6 ± 202.5) for the pre-bundle group and (1243.1 ± 224.7) for the post bundle group. It is higher than the mean birth weight in Kolnik et al. (2023) study (980, 1003, respectively) and this explained why birth weight was not a risk factor in the current study.

Also, Apgar score at one minute was not a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 2.669, $p = 0.054$), which is inconsistent with (29) study, who found that low Apgar score at one minutes was an independent risk factor for occurrence of IVH, which reflect that hemodynamic instability immediately after delivery, and perinatal asphyxia and often need for resuscitation and this may lead to cerebral blood flow fluctuations and rupture of germinal matrix vasculature (16), and this may be related to difference in clinical practice, population characteristic and clinical management protocol.

Likewise, gender was not a significant risk factor for the occurrence of IVH among premature infants (adjusted OR = 0.434, $p = 0.228$). This shows agreement with (24) study finding that shows no association between gender and the occurrence of intraventricular hemorrhage.

Also, neonatal transport in this study was not a significant risk factor for intraventricular hemorrhage occurrence (adjusted OR = 1.190, $p = 0.824$), that inconsistent with (30) study, who found that out-born infant (infant who transfer from other hospital) have a higher risk to developed intraventricular hemorrhage. That means no association between inborn infant and outborn infants in the occurrence of intraventricular hemorrhage in the sample population. This may be related to improved transportation methods, the availability of advanced ambulances with portable incubators, and safer transportation methods (31).

Additionally, mechanical ventilation in this study was not a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 1.190, $p = 0.824$), which reflect that there is no association between early requirement of mechanical ventilation and occurrence of IVH and this inconsistent with (4) study, who found that MV can increase the risk for occurrence of IVH among premature infant, that may be attributed to carbon dioxide (CO₂) level fluctuation and cerebral blood flow, that CO₂ level can affect cerebral autoregulation and increase the vulnerability of fragile germinal matrix vasculature to hemorrhage (32). This finding may be related to adopting of nursing care bundle and closed observation

to mechanical ventilation parameters according to arterial blood gas (ABG) result, it can help in minimizing mechanical ventilation consequence in cerebral hemodynamic (33).

Similarly, umbilical cord blood PH at birth in this study was not a significant risk factor for occurrence of IVH among premature infant (adjusted OR = 0.036, $p = 0.423$), that means no association between initial acid-base level at birth and the occurrence of IVH which is inconsistent with (34) study, who found that abnormal umbilical cord blood PH reading at birth may reflect perinatal asphyxia and metabolic acidosis, which may affect cerebral hemodynamic and cerebral autoregulation, and increase the risk for brain injury include IVH (27). This finding may be attributed to difference in clinical practice and healthcare resources, and the mean of umbilical cord blood PH in the current study was (7.29 ± 0.11) in the pre-bundle group and (7.18 ± 0.91) in the post bundle group, which is considered a normal reading, and it explains why umbilical cord blood PH at birth was not a risk factor in the current study.

Moreover, type of delivery was not a significant risk factor for occurrence of intraventricular hemorrhage (adjusted OR = 0.744, $p = 0.749$), which is inconsistent with (35) study, who reported that CS delivery associated with lower risk of developing IVH compared with NVD, and this may be related to subset sample and small sample size, despite that caesarean section considered the predominant method in this study, but did not influence the outcome. Also, may be related to variation in maternal health status and antenatal care services.

Conclusion

In this Retro-prospective study shows the effectiveness of nursing care bundle in reducing the incidence of intraventricular hemorrhage among premature infant after implementation in the first 72 hour of neonatal period. This result highlights the crucial role in adopting a nursing care bundle in improving neonatal outcomes. Also, the implementation of nursing care bundle shows that Apgar score at five minutes, using of inotropic agent and antenatal steroid administration were a significant predictor for developing IVH among premature infant. On the other hand, gestational age, birth weight, gender, type of delivery, neonatal transport, umbilical cord blood PH at birth, Apgar score at one minutes and mechanical ventilator were not a significant predictor for occurrence of IVH among premature infants.

Recommendations

Based on the results of this study, several recommendations will be identified. First for research, improve the generalizability of this finding by conducting a multi-centre study across NICUs in Palestine with large a sample size. Conduct a Quasi-experimental or Randomized control trial (RCT) to strengthen the evidence based concerning the effectiveness of the nursing care bundle and to better control for potential confounding variables. Investigate the long-term neurodevelopmental outcomes of premature infants following implementation of the IVH nursing care bundle. Second for hospital, Continuous nursing educational and training programmes should be provided to NICU nurses in Palestinian hospital to improve their knowledge and skills concerning IVH bundle prevention. Continuous monitoring and

evaluation of nursing compliance with the IVH bundle prevention. Third for ministry of health, IVH nursing care bundle prevention should be implemented as a standard protocol in the NICUs in Palestinian hospital to improve neonatal outcomes and decrease complications. Institute a neonatal care quality enhancement program to monitor IVH incidence and adherence with IVH prevention protocols across NICUs.

Limitations

In this study, there were many limitations faced. First, as a consequence of a retro prospective design that was used in this study, data were collected from patient's medical records, so some data were messed up. Second, this study was conducted at a single centre, so its generalizability is limited. We need to conduct further studies across multiple centres to confirm this result. Third, a small sample size in this study may affect some variables and show that there was no association with the occurrence of intraventricular hemorrhage, that contradicts the previous studies. Fourth, additional confounders may have been present related to the clinical or perinatal period were measurable. Hence, there may have been some confounding factors that may have influenced the findings.

Abbreviations

Abbreviation	Explanation
IVH	Intraventricular Hemorrhage
NCB	Nursing Care Bundle
NICU	Neonatal Intensive Care Unit
ISH	Ibn Sina Specialized Hospital
GA	Gestational Age
BW	Birth Weight
NVD	Normal Vaginal Delivery
CS	Cesarian Section
TFU	Transfontanelle Ultrasound
NaHCO ₃	Sodium Bicarbonate
VLBW	Very Low Birth Weight
SIVH	Sever Intraventricular Hemorrhage
SIMV	Synchronized Intermittent Mandatory Ventilation
HFO	High Frequency Oscillation
MV	Mechanical Ventilation
G	Gram
RDS	Respiratory Distress Syndrome
IRP	Institutional Review Board
SPSS	Statistical Package for social science
ABG	Arterial Blood Gas

Declarations

Ethics approval and consent to participant: This research complies with the ethics of conducting research activities with human subjects, including a vulnerable population like neonates. The Institutional Review Board (IRB) and Ethics Committee of the Ibn Sina Specialized Hospital was asked to give ethical permission to participate in the study before the actual collection of data. Informed consent not applicable.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated and/or analyzed during the current study are not publicly available due to privacy and confidentiality considerations but may be available from the corresponding author upon reasonable request and with permission from the relevant institution.

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Authors information: ¹ Ibn Sina Specialized Hospital, Jenin, Palestine. ² Faculty of Medicine and Health Sciences, An-Najah National University, Nablus, Palestine.

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