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Prevalence of intraventricular hemorrhage and associated factors to in premature babies in selected teaching hospitals in Rwanda

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Abstract

Background Intraventricular hemorrhage (IVH) is a critical issue in premature infants, caused by the rupture of fragile brain blood vessels due to underdeveloped vasculature. IVH severity, graded by the Papile system in 4 grades, significantly impacts neurodevelopmental outcomes. Despite its severity Data on IVH in sub-Saharan Africa, including Rwanda, is limited.

Objective This study aimed to determine the prevalence of IVH and identify contributing factors among premature infants in selected teaching hospitals in Kigali, Rwanda.

Methodology A retrospective quantitative study analyzed 416 premature infants admitted to 2 Kigali teaching hospitals from 2020 to 2022. Data on demographics, maternal and neonatal factors, and medical interventions were collected from medical records, and statistical analyses, including chi-square tests and multivariate regression, assessed IVH prevalence and association.

Results IVH prevalence was 25.0%, with most cases in grades I and II. Significant factors associated with IVH included neonatal transfer, low gestational age, low Apgar scores, low birth weight, respiratory distress syndrome, maternal infections, emergency cesarean sections, and certain invasive medical interventions such as suction and intubation.

Conclusion This study highlights the complex risk factors for IVH in premature infants, underscoring the need for improved maternal and neonatal care to reduce IVH risk and enhance outcomes. The study's limitations include its retrospective design, which relies on existing medical records that may contain inaccuracies in documentation, and its focus on data from only two hospitals, potentially limiting the generalizability of the findings. Further research is recommended to validate these results and explore long-term neurological development.

Keywords Intraventricular hemorrhage, Premature babies, Prevalence, Risk factors

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Introduction

Intraventricular hemorrhage (IVH) is a severe complication affecting preterm infants, characterized by bleeding into the brain's ventricular system [1]. It occurs when fragile blood vessels in the brain of premature infants rupture, leading to bleeding into the brain ventricular system [2]. IVH is a significant concern due to its association with long-term neurodevelopmental disabilities or death [3]. Intraventricular hemorrhage (IVH) represents a significant complication associated with prematurity, often resulting in adverse long-term developmental consequences. Research indicates that preterm infants who experience low-grade intraventricular hemorrhage are at an increased risk for neurodevelopmental impairments [4, 5]. Furthermore, those with grade II intraventricular hemorrhage face a heightened likelihood of developing cerebral palsy (CP) as well as various non-CP related abnormalities [4, 5].

The prevalence of IVH varies globally, reflecting disparities in healthcare standards, genetics, and environmental factors. In high-income countries, the prevalence ranges from 5–52% [6]. For instance, studies in Europe and North America show prevalence rates between 5% and 52% and 8–22%, respectively [6]. Similarly, Asian studies report IVH rates from 5 to 36%, while in Oceania, the range is 8–13% [6, 7]. In Africa, IVH rates show considerable variability. For example, a study in Egypt reported an incidence of 32.5% [8], while studies in Kenya and Uganda reported prevalences of 33.8% and 34.2%, respectively [2, 9]. South Africa has reported a high prevalence of 44.3% [10], while Ethiopia and Zambia have rates of 27.04% and 34.2% [11–13]. However, these data do not fully represent the countries where the studies were conducted, as they are often drawn from selected hospital populations, which may not reflect the wider national burden in countries where studies were conducted.

Nevertheless, presented statistics underscore the necessity for focused research and interventions aimed at reducing the incidence of intraventricular hemorrhage (IVH) by tackling the maternal and neonatal care factors that play a role in its development. This approach is essential for countries, especially those in Sub-Saharan Africa, to meet the United Nations Sustainable Development Goal 3.2, which seeks to lower neonatal mortality rates to 12 per 1,000 live births and to further decrease neonatal morbidities, including IVH.

The Papile classification system, introduced in 1978, categorizes IVH into grades 1 to 4, with grades 1 and 2 indicating milder forms and grades 3 and 4 indicating more severe involvement [14]. Severe IVH is associated with poorer neurodevelopmental outcomes, such as cerebral palsy and developmental delays, and increases the economic burden on families due to extensive medical care and high cost of prolonged neonatal intensive care unit (NICU) stays [3, 15, 16].

Technological advancements in neonatal care have improved survival rates for preterm infants but when not well utilized can introduce risks for IVH, such as those associated with invasive procedures like umbilical catheterization, suction and intubation [17, 18]. Despite improvements in care, the incidence of IVH remains a significant concern. To address this issue, further research is needed to identify effective preventive strategies and optimize the management of preterm infants at risk for IVH. Additionally, enhancing training for healthcare providers on the risks associated with invasive procedures may help reduce the incidence of severe IVH.

In Rwanda, at least 35,000 babies are born prematurely each year, with 2,600 children under five dying from complications related to preterm birth [19]. A 2022 study by Bankundiye and colleagues. found a 17% prevalence of IVH among extremely low birth weight infants in selected teaching hospitals [20]. However, this study had methodological limitations and focused uniquely on extremely low birth weight (ELBW) infants, leaving a gap in understanding the prevalence and risk factors of IVH among all preterm infants. Therefore, to address this gap, this study was conducted to determine the prevalence of IVH in premature babies and contributing factors in selected teaching hospitals in Kigali. By providing comprehensive data, this research seeks to inform the development of effective preventive strategies and interventions to improve health outcomes for preterm infants in Rwanda. By providing comprehensive data, this research seeks to inform the development of effective preventive strategies and interventions to improve health outcomes for preterm infants in Rwanda.

Methodology

Clinical trial number Not applicable.

Study design

A retrospective quantitative study design was employed to assess the prevalence and contributing factors of IVH in premature infants. Considering the relatively low occurrence of intraventricular hemorrhage (IVH) in premature neonates in Rwanda, a retrospective study design was preferred over a prospective one. This choice was made due to the efficiency of extracting data from both electronic and physical patient records, as opposed to collecting data from patients seeking treatment, which could prolong the identification of new cases and the assessment of IVH prevalence among hospitalized premature infants. The decision to utilize a retrospective design stemmed from the necessity to gather a sufficient sample size, enabling the research team to discern

patterns and trends related to the prevalence of IVH and its associated risk factors.

Study setting

The study was conducted in two prominent teaching hospitals, Rwanda Military Hospital (RMH) and King Faisal Hospital (KFH), both equipped to screen all admitted premature infants for IVH, ensuring strong data collection from a high patient volume. The two hospitals were selected for their capacity to deliver comprehensive neonatal care, high patient volume, and routine IVH screening for premature infants. In the two hospitals catering to critically ill infants, the nurse-to-patient ratio is generally maintained at 1 nurse per neonate, thereby providing focused and intensive care. For patients with moderate illness, this ratio adjusts to approximately 1 nurse for every 3 to 4 neonates. Additionally, patient information is meticulously documented and preserved both electronically and in physical files to guarantee the integrity and completeness of medical records. Each hospital typically admits around 10 premature infants monthly, culminating in an annual total of 120 premature infants per hospital. Both hospitals are staffed with skilled healthcare professionals, including neonatology nurses, neonatologists, and pediatricians, providing 24/7 care. They have strong collaborative networks with specialists in various fields, ensuring adequate nurse-to-neonate ratios for intensive care of critically ill babies.

Study population

The population consisted of all premature infants aged 37 weeks admitted to the NICUs of RMH and KFH during the study period. For inclusion in the study, the files of the infants were required to contain comprehensive information regarding the newborn, the mother, and relevant clinical details pertaining to both the mother and the infant. This included data on antenatal care, neonatal factors such as gestational age, birth weight, cranial ultrasound findings, and maternal perinatal information. Additionally, it was necessary for the files to confirm that the mother survived the childbirth process. Exclusion criteria included full-term infants. Infants born prematurely, specifically those delivered prior to the 37th week of gestation, were excluded from the study if their records contained incomplete or absent information concerning gestational age, birth weight, clinical outcomes, and other critical data necessary for analyzing the factors that may predict the occurrence of IVH. In addition, Infants whose records showed the occurrence of IVH and who passed away within 28 days post-delivery were omitted from the study.

Study sample

The sample comprised medical records of premature babies admitted from January 2020 to December 2022, with a final size of 416 determined by the availability and completeness of records meeting the inclusion criteria. The determination of the sample was contingent upon the accessibility of medical records pertaining to premature infants. To ascertain the sample size, the frequency of premature infant admissions at each hospital was evaluated. On average, each hospital admitted approximately 10 premature infants monthly, resulting in an annual total of 120 premature infants per hospital. Consequently, this led to a cumulative total of 240 premature infants admitted annually across both hospitals. Given that the research was to be conducted in two hospitals, the projected number of admitted premature infants over a three-year period was estimated to be 720. This cohort of 720 premature infants, covering the three years preceding the study, was intended to serve as the sample for the research. However, due to certain documents failing to meet the inclusion criteria, the final sample size was adjusted to 416, rather than the initially planned 720.

Sampling approach

Convenience sampling was used based on the availability of medical records for premature babies admitted from January 2020 to December 2022, covering three years. We systematically reviewed the monthly admission data from selected teaching hospitals to identify the total number of premature baby admissions within this timeframe.

Data collection

Data was extracted from medical records using a structured checklist covering the following variables:

Maternal factors: pre-eclampsia, antenatal corticosteroids, infections, multiple pregnancies, and substance use.

Obstetrical factors: PPROM, chorioamnionitis, mode of delivery.

Fetal/newborn factors: sepsis, glycemia, RDS, birth weight, and resuscitation needs.

Medical interventions: blood transfusions, CPAP, mechanical ventilation, and surfactant administration.

Data retrieved from the hard copy and electronic copy of medical records were entered directly into an electronic dataset that was created using the Statistical Package for Social Science (SPSS) to ensure the accuracy of data collection and to facilitate the data analysis process. Each record was anonymized with a unique code number to maintain confidentiality.

Data analysis

Descriptive statistics summarized demographic and clinical characteristics. IVH prevalence was calculated as the number of IVH cases divided by the total number of premature infants. Bivariate analyses (chi-square tests) was calculated to identify significant associations between potential risk factors and IVH. In addition, multivariate regression analysis was performed to determine which factors are more likely to predict the presence of IVH. Statistical significance was set at $p < 0.05$.

Ethical considerations

Our study was approved by the University of Rwanda review board (CMHS/IRB/059/2024), with permissions from Rwanda Military Referral and Teaching Hospital (Ref: 218/RMH/COMDT/2024) and King Faisal Hospital (KFH/2024/153/IRB). Confidentiality and privacy were upheld by anonymizing data and restricting access to authorized personnel [21]. Our study involved the documents' reviews, and the consent to participate in the study was not applicable. However, a data-sharing agreement was signed with legal advisors of the respective institutions where the study was conducted.

Data management involved secure retrieval, collection, manipulation, and storage. Confidentiality was ensured by assigning unique codes to patient files and securing data with password protection. Data were stored on a protected flash drive or personal email for backup and retained for five years before destruction.

Results

The total number of premature infants admitted to the NICUs of RMH and KFH over the three years was 416, among whom, 52.2% were male (217), and 47.8% were female (199). This sample included only those infants who met the inclusion criteria of being born 37 weeks before gestation and having complete medical records, including cranial ultrasound results.

IVH prevalence and grading within this subset

A quarter of the sample presented IVH. Grade I IVH was the most prevalent, 12.7% of all cases. IVH was identified in 25.0% of the total sample, equating to 104 babies. Among these 104 neonates diagnosed with IVH, the distribution across the various grades was as follows: grade 1 in 12.7% (53 neonates), grade 2 in 6.0% (25 neonates), grade 3 in 2.9% (12 neonates), and grade 4 in 3.4% (14 neonates).

Associations between newborn and maternal demographics, clinical status at birth, with the prevalence of IVH

Table 1 shows the relationships between maternal and newborn demographic factors, and clinical conditions at birth, with the prevalence of IVH. For newborns the transfer, exhibited a strong association with IVH prevalence ($p = 0.00$). Gestational age was also significant, with infants born between 24 and 30 weeks showing higher rates of IVH ($p = 0.00$). Low Apgar scores at one, five, and ten minutes correlated with increased IVH prevalence, particularly for scores between 4 and 6 (first minute: ($p = 0.00$); fifth minute: ($p = 0.00$); tenth minute: ($p = 0.00$). Very low birth weights were linked to a heightened risk of IVH ($p = 0.00$). Interestingly, appropriate-for-gestational-age infants showed a surprising rise in IVH prevalence ($p = 0.030$). On the maternal side, emergency cesarean sections significantly correlated with IVH ($p = 0.000$). Multiple pregnancies were associated with IVH ($p = 0.010$), though single pregnancies had the highest prevalence. Significant associations were also found with antenatal corticosteroid administration ($p = 0.000$), maternal infections during pregnancy ($p = 0.000$), and preterm premature rupture of membranes lasting over 18 h ($p = 0.000$), indicating a complex interplay of factors contributing to IVH risk.

Associations between newborn clinical factors and medical interventions on the prevalence IVH

Table 2 shows the associations between newborn clinical factors and medical interventions on the prevalence of IVH. It reveals several statistically significant findings. Neonatal infection showed a significant association with IVH ($p = 0.000$), indicating a strong relationship between the presence of infection and increased IVH prevalence. Similarly, temperature on admission ($p = 0.000$) and respiratory distress syndrome ($p = 0.000$) were also significantly associated with IVH. Neonatal resuscitation during hospitalization demonstrated a profound significance ($p = 0.000$), highlighting its critical role in IVH prevalence. Other significant associations included blood transfusion ($p = 0.000$) and the need for intubation and mechanical ventilation ($p = 0.000$). In contrast, glycemia on admission ($p = 0.102$) and continuous positive airway pressure (CPAP) ($p = 0.130$) were not statistically significant, suggesting that these factors may not have a meaningful impact on IVH prevalence. Overall, these results indicate that specific clinical factors and medical interventions significantly influence the occurrence of IVH in newborns.

Factors predicting the presence of IVH among neonates

Newborn demographic and clinical Status at birth and maternal demographic and obstetric factors associated with IVH.

Table 3 presents the maternal and newborn demographic and clinical factors associated with the occurrence of IVH. Maternal age significantly influences IVH risk, particularly for mothers aged 31 to 40 years (OR:

Table 1 Associations between newborn and maternal demographics, clinical status at birth, with the prevalence of IVH

Factors	Prevalence of IVH		Total	Statistical Significance
	Absent *n* (%)	Present *n* (%)		
Associations between newborn demographics, clinical status at birth and prevalence of IVH				
Gender				
Male	53 (12.7%)	164 (39.4%)	217 (52.2%)	$X^2 = 0.080$, $p = 0.772$
Female	51 (12.3%)	148 (35.6%)	199 (100%)	
Where neonate transferred from				
District hospital	12 (2.9%)	26 (6.3%)	38 (9.1%)	$X^2 = 156.532$, $p = 0.000$
Private clinic/hospital	11 (2.6%)	26 (6.3%)	37 (8.9%)	
Referral hospital	12 (2.9%)	25 (6.0%)	37 (8.9%)	
No transfer	277 (66.6%)	27 (6.5%)	304 (73.1%)	
Gestational weeks range				
24 to 30 weeks	67 (16.1%)	78 (18.8%)	145 (34.9%)	$X^2 = 99.208$, $p = 0.000$
31 to 34 weeks	238 (57.2%)	24 (5.8%)	262 (63.0%)	
35 to 37 weeks	7 (1.7%)	*2 (0.5%)	9 (2.2%)	
Apgar score in the first minute				
0 to 3	*1 (0.2%)	26 (6.3%)	27 (6.5%)	$X^2 = 132.713$, $p = 0.000$
4 to 6	100 (24.0%)	64 (15.4%)	164 (39.4%)	
7 to 10	211 (50.7%)	14 (3.4%)	225 (54.1%)	
Apgar Score in the fifth minute				
4 to 6	9 (2.2%)	65 (15.6%)	74 (17.8%)	$X^2 = 189.557$, $p = 0.000$
7 to 10	303 (72.8%)	39 (9.4%)	342 (82.2%)	
Apgar Score in the tenth minute				
4 to 6	*5 (1.2%)	66 (15.9%)	71 (17.1%)	$X^2 = 210.867$, $p = 0.000$
7 to 10	307 (73.8%)	38 (9.1%)	345 (82.9%)	
Birth weight classifications				
Low birth weight	9 (2.2%)	46 (11.1%)	55 (13.2%)	$X^2 = 116.370$, $p = 0.000$
Very low birth weight	282 (67.8%)	53 (12.7%)	335 (80.5%)	
Extremely low birth weight	21 (5.0%)	5 (1.2%)	26 (6.3%)	
Birth weight compared to gestational age				
Appropriate for gestational age	216 (51.9%)	70 (16.8%)	286 (68.8%)	$X^2 = 7.015$, $p = 0.030$
Small for gestational age	70 (16.8%)	32 (7.7%)	102 (24.5%)	
Large for gestational age	26 (6.3%)	2 (0.5%)	28 (6.7%)	
Associations between maternal demographic and clinical status with the prevalence of IVH				
Maternal age range				
From 20 to 30	57 (13.7%)	24 (5.8%)	81 (19.5%)	$X^2 = 6.325$, $p = 0.097$
From 31 to 40	177 (42.5%)	53 (12.7%)	230 (55.3%)	
From 41 to 50	67 (16.1%)	18 (4.3%)	85 (20.4%)	
Below 20	11 (2.6%)	9 (2.2%)	20 (4.8%)	
Mode of delivery				
Planned cesarean section	161 (38.7%)	13 (3.1%)	174 (41.8%)	$X^2 = 55.557$, $p = 0.000$
Emergency cesarean section	118 (28.4%)	57 (13.7%)	175 (42.1%)	
Spontaneous vaginal delivery	33 (7.9%)	34 (8.2%)	67 (16.1%)	
Multiple pregnancies				
Single pregnancy	109 (40.6%)	78 (18.8%)	247 (59.4%)	$X^2 = 16.239$, $p = 0.010$
Twin pregnancy	61 (14.7%)	16 (3.8%)	77 (18.5%)	
Triplet pregnancy	59 (14.2%)	7 (1.7%)	66 (15.9%)	
Quadruplet pregnancy	23 (5.5%)	*3 (0.7%)	26 (6.3%)	
Completion of 4 doses of antenatal corticosteroids				
Yes	248 (59.6%)	42 (10.1%)	290 (69.7%)	$X^2 = 56.484$, $p = 0.000$
No	64 (15.4%)	62 (14.9%)	126 (30.3%)	
Maternal infection during pregnancy				
Yes	91 (21.9%)	66 (15.9%)	157 (37.7%)	$X^2 = 39.043$, $p = 0.000$
No	221 (53.1%)	38 (9.1%)	259 (62.3%)	

Table 1 (continued)

Factors	Prevalence of IVH		Total	Statistical Significance
	Absent *n* (%)	Present *n* (%)		
Maternal Preeclampsia or Eclampsia				
Yes	205 (49.3%)	67 (16.1%)	272 (65.4%)	$X^2 = 0.57$, $p = 0.812$
No	107 (25.7%)	37 (8.9%)	144 (34.6%)	
PPROM above 18 h				
Yes	95 (22.8%)	62 (14.9%)	157 (37.7%)	$X^2 = 28.239$, $p = 0.000$
No	217 (52.2%)	42 (10.1%)	259 (62.3%)	
Clinical chorioamnionitis (foul-smelling amniotic fluids)				
Yes	283 (68.0%)	56 (13.5%)	339 (81.5%)	$X^2 = 70.225$, $p = 0.000$
No	29 (7.0%)	48 (11.5%)	77 (18.5%)	

4.921, 95% CI: [1.402–17.269], $p = 0.013$) and those aged 41 to 50 years (OR: 5.236, 95% CI: [1.208–22.684], $p = 0.027$). The administration of four doses of antenatal corticosteroids is crucial, as it notably lowers IVH risk (OR: 4.763, 95% CI: [2.636–8.605], $p < 0.001$). Furthermore, the absence of foul-smelling amniotic fluid related to clinical chorioamnionitis is associated with a lower likelihood of IVH (OR: 0.262, 95% CI: [0.123–0.558], $p = 0.001$). Delivery methods also significantly impact IVH, with spontaneous vaginal delivery and emergency cesarean sections linked to an increased risk (OR: 4.907, 95% CI: [1.957–12.305], $p = 0.001$). In terms of newborn factors, transfers from District Hospitals, Private Clinics, or Referral Hospitals significantly affect IVH occurrence (OR: 0.058, 95% CI: [0.016–0.216], $p < 0.001$). Infants classified as small for gestational age have a higher risk of IVH (OR: 0.449, 95% CI: [0.057–3.520], $p = 0.046$) compared to those appropriate for gestational age. Additionally, very low birth weight infants are more susceptible to IVH (OR: 3.603, 95% CI: [0.790–16.430], $p = 0.048$), although caution is advised in interpreting this due to the mortality of many extremely low birth weight infants before brain ultrasound assessment. Lastly, infants with Apgar scores between 4 and 6 face a significantly higher IVH risk (OR: 0.036, 95% CI: [0.010–0.130], $p < 0.001$) compared to those with scores of 7 to 10, highlighting the critical role of both maternal and newborn factors in IVH prevention.

Neonatal clinical, medical condition, and intervention factors contributing to IVH

Table 4 highlights neonatal clinical, medical conditions, and intervention factors contributing to IVH. Neonates with infections, either congenital or nosocomial, had a significant risk of IVH (OR: 0.107, 95% CI: [0.042–0.274], $p < 0.001$). Hypothermia on admission also increased the likelihood of IVH (OR: 10.153, 95% CI: [4.637–22.231], $p < 0.001$). Additionally, longer hospital stays substantially raised the risk of IVH ($p < 0.001$). Regarding interventions, neonatal resuscitation involving stimulation, suction, and bag-mask ventilation significantly increased IVH risk (OR: 6.748, 95% CI: [6.748–67.484], $p < 0.001$). Mechanical ventilation (OR: 0.156, 95% CI: [0.067–0.365], $p < 0.001$) and surfactant administration reduced the risk of IVH (OR: 0.461, 95% CI: [0.216–0.983], $p = 0.045$).

Discussion

This study aimed to assess the prevalence and to determine the prevalence of IVH in premature infants at teaching hospitals in Kigali, conducted from January 2020 to December 2022. The study included 416 premature infants, revealing a 25% prevalence of IVH, significantly higher than in developed countries where advanced neonatal care has reduced IVH rates. For instance, IVH prevalence ranges from 1.2 to 14% in California [22]. Comparatively, IVH prevalence in low- and middle-income countries (LMICs) shows variability, with 34.2% in Zambia 8 and 44.3% in South Africa [10]. This variability highlights the disparities in healthcare quality between resource-rich and resource-limited settings. Regarding the grades, our study found that most cases were predominantly lower-grade IVH, with grade I being the most frequent (12.7%). This finding is consistent with literature indicating that lower-grade IVH is more common but can progress if not detected early [9, 12]. Early detection and intervention are crucial to prevent progression to higher grades, as supported by similar studies [12, 23].

Neonatal transfer from different settings is linked to IVH due to potential instability during transfer, delayed care, and transportation stress. Other studies also found higher IVH risks in transferred infants compared to inborn ones [12, 24], emphasizing the role of in-utero transfer for babies who are at risk of being born prematurely.

Lower Apgar scores at the first, fifth-, and tenth minutes after birth are significant indicators of increased risk for IVH. Neonates with Apgar scores of 4 to 6 are more likely to develop IVH compared to those with scores of 7 to 10. This aligns with existing knowledge that lower Apgar scores, reflecting poor physiological status at birth,

Table 2 Associations between newborn clinical factors and medical interventions on the prevalence IVH

Factors	Prevalence of IVH		Total	Statistical Significance
	Absent *n* (%)	Present *n* (%)		
Associations between newborn clinical factors and prevalence of IVH				
Neonatal infection either congenital or nosocomial				
Presence of infection	129(31.0%)	96(23.1%)	225(54.1%)	$X^2 = 81.574$, $p = 0.000$
Absence on infection	183(44.0%)	8(1.9%)	191(45.9%)	
Glycemia on admission				
Normal glycemia	276(66.3%)	88(21.2%)	364(87.5%)	$X^2 = 4.565$, $p = 0.102$
Hypoglycemia	25(6.0%)	7(1.7%)	32(7.7%)	
Hyperglycemia	11(2.6%)	9(2.2%)	20(4.8%)	
Temperature on admission				
Normothermic	287(69.0%)	51(12.3%)	338(81.2%)	$X^2 = 94.443$, $p = 0.000$
Hypothermic	25(6.0%)	53(12.7%)	78(18.8%)	
Respiratory distress syndrome				
Yes	253(60.8%)	100(24.0%)	353(84.9%)	$X^2 = 13.774$, $p = 0.000$
No	59(14.2%)	4(1.0%)	63(15.1%)	
Neonatal resuscitation on admission and/or during hospital stay				
None	146(35.1%)	3(0.7%)	149(35.8%)	$X^2 = 195.284$, $p = 0.000$
Stimulation	67(16.1%)	17(4.1%)	84(20.2%)	
Stimulation and suction	93(22.4%)	25(6.0%)	118(28.4%)	
Stimulation, suction and bag-mask ventilation	6(1.4%)	38(9.1%)	44(10.6%0	
Chest compression and/or Adrenaline	0(0.0%)	21(5.0%)	21(5.0%)	
Association between newborn medical intervention and prevalence of IVH				
Neonatal blood transfusion during hospitalization				
Yes	131(31.5%)	91(21.9%)	222(53.4%)	$X^2 = 64.992$, $p = 0.00$
No	181(43.5%)	13(3.1%)	194(46.6%)	
Continuous positive airway pressure (CPAP)				
Yes	269(64.7%)	99(23.8%)	368(88.5%)	$X^2 = 6.155$, $p = 0.130$
No	43(10.3%)	5(1.2%)	48(11.5%)	
Intubated and mechanical ventilation				$X^2 = 136.248$, $p = 0.000$
Yes	15(3.6%)	57(13.7%)	72(17.3%)	
No	297(71.4%)	47(11.3%)	344(82.7%)	
Neonatal suction during hospitalization				
Nasal, mouth or endotracheal tube suction	156(37.5%)	95(22.8%)	251(60.3%)	$X^2 = 55.718$, $p = 0.000$
No suction required	156(37.5%)	9(2.2%)	165(39.7%)	
Neonate received surfactant				
Yes	41(9.9%)	30(7.2%)	71(17.1%)	$X^2 = 13.592$, $p = 0.000$
No	271(65.1%)	74(17.8%)	345(82.9%)	
Days of hospital stay				
0 to 10days	36(8.7%)	3(0.7%)	39(9.4%)	$X^2 = 151.006$, $p = 0.000$
11 to 20days	72(17.3%)	7(1.7%)	79(19.0%)	
21 to 30days	107(25.7%)	12(2.9%)	119(28.6%)	
31 to 40days	76(18.3%)	20(4.8%)	96(23.1%)	
51 to 60days	14(3.4%)	18(4.3%)	32(7.7%)	
Above 60days	7(1.7%)	44(10.6%)	51(12.3%)	

are associated with higher risks of adverse outcomes, including IVH [25]. This reflects the need for knowledge in neonatal resuscitation.

Completion of four doses of antenatal corticosteroids was found to significantly reduce the risk of IVH. This finding aligns with existing literature that emphasizes the importance of corticosteroids in promoting fetal lung maturity and reducing neonatal complications in preterm births [26]. Ensuring that expectant mothers at risk of preterm delivery receive the complete regimen of antenatal corticosteroids could be a key strategy in mitigating IVH risk.

Hypothermia on admission markedly increased the risk. Hypothermia is known to impair coagulation and

Table 3 Newborn demographic and clinical status at birth and maternal demographic and obstetric factors associated with IVH

Variables		*P* value	Odds ratio (OR)	95%Confidence interval (CI)
Newborn demographic and clinical status at birth				
Sex of neonate	Male	0.586	1.284	[0.522–3.156]
	Female	.	.	.
Place of referral	District Hospital	0.000	0.058	[0.016–0.216]
	Private clinic/hospital	0.001	0.104	[0.027–0.403]
	Referral hospital	0.000	0.079	[0.022–0.281]
	No transfer	.	.	.
Gestational age range	24 to 30weeks	0.086	0.245	[0.049–1.222]
	31 to 34weeks	0.210	2.833	[0.557–14.411]
	35 to 37 weeks	.	.	.
Birth weight classifications	Low birth weight	0.786	0.752	[0.096–5.867]
	Very low birth weight	0.048	3.603	[0.790–16.430]
	Extremely low birth weight	.	.	.
Apgar score in the first minute	Apgar from 0 to 3	0.124	0.099	[0.005–1.886]
	Apgar from 4 to 6	0.203	0.522	[0.192–1.421]
	Apgar from 7 to 10	.	.	.
Apgar score in the fifth minute	Apgar from 4 to 6	0.000	0.036	[0.010–0.130]
	Apgar from 7 to 10	.	.	.
Apgar score in the tenth minute	Apgar from 4 to 6	0.000	0.045	[0.012–0.170]
	Apgar from 7 to 10	.	.	.
Birth weight compared to gestational age	Appropriate for gestation	0.338	0.381	[0.053–2.746]
	Small for gestation age	0.046	0.449	[0.057–3.520]
	Large for gestational age	.	.	.
Maternal demographic and obstetrics factors				
The maternal age range	From 20 to 30	0.114	2.912	[0.773–10.975]
	From 31 to 40	0.013	4.921	[1.402–17.269]
	From 41 to 50	0.027	5.236	[1.208–22.684]
	Below 20	.	.	.
Maternal Preeclampsia or Eclampsia	Yes	0.331	0.718	[0.368–1.401]
	No	.	.	.
Did the mother complete 4 doses of antenatal corticosteroids	Yes	0.000	4.763	[2.636–8.605]
	No	.	.	.
Did the mother get an infection during pregnancy	Presence of infection in pregnancy	0.012	0.585	[0.302–1.133]
	No infection during pregnancy	.	.	.
Multiple pregnancies	Single pregnancy	0.439	1.833	[0.395–8.495]
	Twin pregnancy	0.130	3.630	[0.683–19.298]
	Triplet pregnancy	0.112	3.955	[0.727–21.516]
	Quadruplets pregnancy	.	.	.
PPROM above 18 h	No	0.177	0.617	[0.307–1.243]
	Yes	.	.	.
Clinical chorioamnionitis (foul-smelling amniotic fluids)	No	0.001	0.262	[0.123–0.558]
	Yes	.	.	.
Mode of delivery	Spontaneous vaginal delivery	0.001	4.907	[1.957–12.305]
	Emergency cesarian section	0.044	0.733	[0.331–1.624]
	Planned cesarian section	.	.	.

can exacerbate the fragility of cerebral vessels in preterm infants, leading to an increased risk of IVH. These results highlight the necessity of maintaining normothermia in premature infants as part of standard care practices.

The duration of hospital stay emerged as a critical factor, with longer stays correlating with a significantly higher risk of IVH. This trend underscores the compounding effects of prolonged hospitalization, including the potential for increased exposure to invasive

Table 4 Neonatal clinical, medical condition, and intervention factors contributing to IVH

Variables		*P* value	Odds ratio (OR)	95% Confidence interval (CI)
Newborn clinical and medical condition factors				
Neonatal infection either congenital or nosocomial	Presence of infection	0.000	0.107	[0.042–0.274]
	No infection	.	.	.
Glycemia on admission	Normal	0.720	1.315	[0.294–5.878]
	Hypoglycemia	0.128	4.255	[0.661–27.404]
	Hyperglycemia	.	.	.
Temperature on admission	Normothermic	0.000	10.153	[4.637–22.231]
	Hypothermic	.	.	.
Respiratory distress syndrome	Yes	0.376	0.532	[0.131–2.155]
	No	.	.	.
Days of hospital stay	1 to 10days	0.000	25.556	[4.975-131.283]
	11 to 20days	0.000	27.380	[7.067-106.084]
	21 to 30days	0.000	45.118	[14.276-142.591]
	31 to 40days	0.000	22.292	[7.443–66.760]
	51 to 60 days	0.019	4.421	[1.275–15.335]
	Above 60days	.	.	.
Neonatal medical intervention factors				
Neonatal resuscitation during hospital stays	None	0.450	6.879	[14.778–32.024]
	Stimulation	0.020	1.236	[4.010–38.120]
	Stimulation and suction	0.002	1.237	[4.207–36.318]
	Stimulation, suction, bag-mask ventilation	0.000	6.748	[6.748–67.484]
	Chest compression	.	.	.
The neonate received a blood transfusion during hospitalization	Yes	0.417	0.706	[0.304–1.638]
	No	.	.	.
Continuous positive airway pressure (CPAP)	Yes	0.546	0.552	[0.080–3.808]
	No	.	.	.
Intubated and mechanical ventilation	Yes	0.000	0.156	[0.067–0.365]
	No	.	.	.
Suction required during hospital stay	Nasal, mouth or endotracheal tube suction	0.000	0.136	[0.063–0.290]
	No suction required	.	.	.
Neonate received surfactant	Yes	0.045	0.461	[0.216–0.983]
	No	.	.	.

procedures, infections, and other stressors that could contribute to IVH. These findings reflect the evidence-based practice done for reducing IVH, where they found that minimal handling, reducing painful procedures, and reducing noise and light during hospital stays reduced IVH [27, 28].

Neonatal suction, whether nasal, oral, or via endotracheal tube, was also significantly associated with higher IVH prevalence. These findings reflect those of previous studies which underscored the contribution of painful procedures leading to the risk of IVH [29, 30]. This suggests that the physical manipulation and potential stress associated with suctioning procedures could contribute to the development of IVH in these infants. This finding underscores the importance of minimizing invasive procedures when possible and utilizing gentle suction techniques to reduce the risk of IVH.

Mode of delivery significantly influences IVH risk. Emergency cesarean Sect. (13.7%) and spontaneous vaginal deliveries (8.2%) are linked to higher IVH rates compared to planned cesarean Sect. (3.1%). Emergency deliveries may lead to missed antenatal corticosteroid doses and increased stress, corroborating previous research that indicates higher IVH rates with emergency and spontaneous deliveries compared to planned cesarean Sects. [28, 31, 32]. These findings suggest that planned cesarean deliveries might improve outcomes for high-risk pregnancies.

Strengths and limitations

This study is the first of its kind in Rwanda, investigating the prevalence and risk factors of IVH in premature infants, thus filling a critical gap in local neonatal research. The study, spanning three years, included a significant sample size of 416 infants, offering comprehensive insights into neonatal, maternal, and delivery-related risk factors to IVH in Rwanda.

However, as a retrospective study, it faced limitations such as reliance on potentially inconsistent medical records and incomplete documentation, affecting the accuracy and generalizability of the findings. Additionally, missing data on maternal health, neonatal outcomes, and the conditions of neonatal transfers, along with the lack of electronic medical records, posed challenges. The study also lacked follow-up data, preventing the assessment of long-term outcomes for infants with IVH. These limitations highlight the need for more comprehensive, prospective research on IVH in this population.

Conclusion

The study investigated the prevalence and contributing factors of IVH among 416 premature infants in Kigali, Rwanda, from 2020 to 2022. The study found a 25% prevalence of IVH, highlighting significant healthcare challenges. Key risk factors included gestational age, Apgar scores, birth weight, mode of delivery, maternal infections, and neonatal interventions like blood transfusions. The findings stress the importance of enhanced prenatal care and optimal neonatal management to mitigate IVH risks. Recommendations include improving IVH screening, training healthcare providers, standardizing care practices, and conducting further research to improve outcomes. Further research should examine long-term neurodevelopmental outcomes, and environmental factors, and conduct multicenter studies to improve generalizability.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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Author contributions

Jeanne Uwizeyimana, Marie Grace Sandra Musabwasoni, Thierry Claudien Uhawenimana prepared the proposal of this study, did data collection, and analysis. Jeanne Uwizeyimana, Marie Grace Sandra Musabwasoni, Christine Mbila Wabenya, Winifride Murekatete, Larissa Flave Ishimwe, Pacifique Umubyeyi, Alex Lola Mwana Ngoye, Glorieuse Uwingabiye, Thierry Claudien Uhawenimana made equal contributions to both the preparation and review of the submitted manuscript.

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Data availability

The results section of this manuscript encompasses all pertinent data, and we have included the SPSS dataset as a supplementary document to facilitate verification of the findings reported herein.

Declarations

Human ethics and consent to participate

Ethical approval to conduct our study was obtained from the University of Rwanda, College of Medicine and Health Sciences, Institutional Review Board (CMHS/IRB/059/2024). Additional permissions to collect data were obtained from Rwanda Military Referral and Teaching Hospital (Ref: 218/RMH/COMDT/2024) and King Faisal Hospital (KFH/2024/153/IRB). Confidentiality and privacy were upheld by anonymizing data and restricting access to authorized personnel. Our study involved the document review, and we did not interview or administer questionnaire to any personnel or parents of the neonates. As a result, consent to participate in the study was not applicable. However, we signed a data-sharing agreement with legal advisors of the respective institutions where the study was conducted.

Consent for publication

N/A.

Competing interests

The authors declare no competing interests.

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