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Factors Associated with Mortality of Newborns of Hypertensive Mothers in Bukavu, Democratic Republic of the Congo

Nisa Furaha Bidorho[1*], Mambo Mwilo[1,2], Neneh Luhiriri Mwindja[1,2], John Mulindwa[1], Heri Bulambo[1], Eric Munguakonkwa Ntagereka[1], Omari Mukanga[1], Léonard Kanku Tudiakwile[1,2], Archippe Birindwa Muhandule[1,2]

[1]Panzi General Reference Hospital, Bukavu, Democratic Republic of the Congo
[2]Faculty of Medicine, University Evangelic in Africa, Bukavu, Democratic Republic of the Congo
Email: *nisafuraha@gmail.com

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Abstract

Hypertensive disorders of pregnancy represent the leading cause of perinatal morbidity and mortality in developing countries. Thus, the aim of this study was to evaluate the factors associated with mortality in newborns of hypertensive mothers. This is a prospective descriptive study with analytical aims, which collected 89 newborns of hypertensive mothers in the obstetric gynecology and neonatology departments of Panzi GRH from February 20, 2021 to May 20, 2022. Blood sampling from the umbilical artery was carried out in the delivery room, and biochemical analysis was performed using the Edan device. We collected 86 samples among which metabolic acidosis accounted for 33.7%, respiratory acidosis 32.6%, 27.9% mixed acidosis, pH ≤ 7.20 37.2%. Respiratory distress (p = 0.001), Apgar score at 5th minute (p = 0.020), resuscitation at birth (p = 0.001) are statistically associated with pH ≤ 7.20. The risk of newborn death was associated with a history of abortion in the mothers, with a risk multiplied by (HR = 2.73), less than 4 prenatal consultation (PNC) during pregnancy (HR = 2.96), antenatal corticosteroid therapy (HZ = 7.11), prematurity (HZ = 7.19), low birth weight (HR = 8.63), resuscitation of newborns (HR = 8.59), transfer to neonatology (HR = 7.05) and presence of complications in newborns (HR = 16.01). Mortality of newborns born to hypertensive mothers is associated with a history of maternal abortion, low birth weight, resuscitation in the delivery room, transfer to neonatology, gestational age and complications during hospitalization in neonatology. Since respiratory distress is associated with severe acidosis, systematic analysis of pH and blood gases at the umbilical cord remains necessary for neonatal management.

Subject Areas

Pediatrics

Keywords

Associated Factors, Mortality, Neonate

1. Introduction

According to the guidelines of the American College of Obstetricians and Gynecologists (ACOG), hypertensive disorders of pregnancy (HDP) are classified according to the time of onset, between 20 weeks gestation and 12 weeks postpartum, as well as the presence of proteinuria and signs of severity. On this basis, their typologies are divided into chronic arterial hypertension, chronic hypertension with added pre-eclampsia, isolated pre-eclampsia, pre-eclampsia with severe and eclampsia [1].

Perinatal morbidity is dominated by hypoxic syndrome resulting in IUGR, hypotrophy, in-utero death and premature delivery. Pregnancy-induced hypertension is formally recognized as the leading cause of medically indicated premature delivery in the USA, and significantly increases the risk of neonatal death compared with normal pregnancy [2].

Neonatal complications range from prematurity to fetal growth restriction. The latter is the most frequent neonatal complication in newborns of hypertensive mothers. Perinatal mortality rates for newborns with IUGR are 6 to 10 times higher than for those with normal growth. Other morbidities described in newborns of hypertensive mothers include bronchopulmonary dysplasia, retinopathy of prematurity, sepsis and longer duration of mechanical ventilation. Exposure to HDP may be associated with an increased risk of autism spectrum disorders and attention deficit/hyperactivity disorder. These findings underline the need for greater pediatric surveillance of newborns exposed to HDP, to enable early interventions that may improve neurodevelopmental outcomes [3].

Among newborns admitted to intensive care, the survival rate without serious sequel is estimated at 33%, while the risk of cognitive disorders is around 70%, with impairment of language, memory or executive functions such as planning or logical reasoning [2].

Neonatal morbidity in the newborns of pre-eclampsia mothers seems to be closely linked to prematurity, and the evolution depends on gestational age and birth weight [4].

2. Methodology

2.1. Study Setting

Our study was carried out at Panzi GRH, located in the city of Bukavu, capital of South Kivu Province in the east of the Democratic Republic of Congo. Created

in 1999 by the Community of Pentecostal Churches in Central Africa, the hospital currently comprises five departments: Surgery, Gyneco-obstetrics, Internal Medicine, Pediatrics and Medical Imaging.

The pediatrics department comprises three services: pediatric emergencies, Inpatient Therapeutic Feeding Center (ITFC) and neonatology.

This work was carried out in the gynecology-obstetrics department, in neonatology and in the laboratory at Panzi GRH.

2.2. Type of Study

This is a prospective descriptive study with analytical aims.

2.3. Study Period

From February 20th 2021 to May 20th 2022, that is 15 months period.

2.4. Study Population

- Inclusion criteria: newborns whose mothers had HDP, born at Panzi GRH and whose umbilical cord had been sampled for gazometry.
- Exclusion criteria: newborns whose delivery did not take place at Panzi GRH.
- Sampling: exhaustive.

2.5. Data Collection Technique and Tools

- Training of a team in umbilical cord blood sampling.
- A data collection form was used to collect data on the mothers, the pregnancy progress, extra uterine adaptation, clinical and biochemical characteristics of the newborns and their evolution.

2.6. Biochemical Variables Analyzed and Their Reference Ranges

The Edan i15 blood gas and biochemistry analyzer (including blood gas and biochemistry analyzer, standard solution pack, test cartridge) was used for blood gas analysis. It is a portable automated system that measures blood gases and biochemistry, as well as hematocrit in whole blood samples. By providing timely test results, the system enables healthcare professionals to make more rapid therapeutic decisions, thereby improving the quality of patient care.

Umbilical artery blood was collected using a 1 ml heparinized syringe and analyzed using a BG10 cartridge.

PH [7.35 - 7.45]

pCO_2 [35.0 - 45.0] mmHg

pO_2 [80.0 - 105.0] mmHg

Lactates [0.50 - 1.60] mmol/L

HCO_3^- [22 - 28] mmol/L

Na^+ [136.0 - 145.0] mmol/L

K^+ [3.50 - 5.1] mmol/L

Ca^{2+} [1.13 - 1.32] mmol/L

Cl^- [98 - 109] mmol/L
Glu [3.9 - 6.1] mmol/L

2.7. Data Management and Analysis

Data were collected on a paper questionnaire, entered into Microsoft Excel 2013 and analyzed using Stata SE 14.0 (Stata Corp LP, College Station, Texas, USA).

For raw analysis, descriptive statistics included means and their standard deviations (SDs), as well as medians with interquartile ranges (IQRs) for continuous variables. Categorical variables were summarized in frequencies and proportions.

To compare proportions, we used Pearson's chi-square test or Fisher's exact test for proportions below 5.

Cox proportional regression and hazard ratios were calculated to measure the risk of death in children born to hypertensive mothers. The test was significant when the p-value was less than 0.05.

2.8. Ethical Considerations

- Individual patient code to guarantee anonymity.
- Our study protocol was approved by the National Health Ethics Committee. Registration number: CNES 001/DPSK/151PP/2021.

3. Results

We collected 86 samples among which metabolic acidosis accounted for 33.7% of cases, respiratory acidosis 32.6%, and mixed acidosis 27.9%. Lactate levels were below 8 in 89.5% of cases. We noted hypoglycemia in 40.7% and hyperglycemia in 7%. Hyponatremia in 54.7%, hyperkalemia in 34.9% and hypokalemia in 9.3%. Hypercalcemia in 67.4% vs. hypocalcemia in 3.5% and pH ≤ 7.20 in 37.2% (Table 1).

There were statistically significant associations between gestational age, antenatal corticosteroid therapy and neonatal mortality (Table 2).

We found statistically significant associations between low birth weight, the notion of resuscitation, transfer to neonatology and poor neonatal outcome ($p < 0.05$), a statistically significant association between the presence of neonatal complications and neonatal outcome ($p < 0.001$) (Table 3 and Table 4).

Respiratory distress, Apgar score at 5 minutes < 7, and resuscitation in neonates were respectively associated with pH ($p = 0.001$), ($p = 0.020$) and ($p = 0.001$) (Table 5).

According to the Cox regression of factors associated with newborn death, the risk of newborn death was associated with a history of maternal abortion, with a risk multiplied by (HR = 2.73; 95% CI: 1.79 - 9.46; p = 0.025), number of PNC less than 4 during pregnancy (HR = 2.96; 95% CI: 1.45 - 3.55; p = 0.011), antenatal corticosteroid therapy (HZ = 7.11; 95% CI: 1.83 - 27.53; p = 0.005), prematurity (HZ = 7.19; 95% CI: 1.91 - 56.78; p = 0.047), low birth weight (HR = 8.63; 95% CI: 2.45 - 14.56; p < 0.001), newborn resuscitation (HR = 8.59; 95% CI:

Table 1. Paraclinical examinations.

Characteristics	n = 86 (%)
Type of acidosis	
Normal	5 (5.8)
Metabolic acidosis	29 (33.7)
Respiratory acidosis	28 (32.6)
Mixed acidosis	24 (27.9)
Lactates	
<8	77 (89.5)
≥8	9 (10.5)

Table 2. Classification of HTA, delivery and complications in mothers versus evolution of newborns.

Caracteristics	Evolution of newborns		p-Value
	Death (n = 10)	Alive (n = 76)	
Class of hypertension			0.342
Preeclampsia	9 (14.5)	53 (85.5)	
Preeclampsia + chronic hypertension	1 (20.0)	4 (80.0)	
Gestational hypertension	0 (0.0)	16 (100.0)	
Chronic hypertension	0 (0.0)	3 (100.0)	
Eclampsia			0.468
No	8 (10.7)	67 (89.3)	
Yes	2 (18.2)	9 (81.8)	
HELLP			0.821
No	8 (11.3)	63 (88.7)	
Yes	2 (13.3)	13 (86.7)	
Acute Renal Failure (ARF)			0.393
No	9 (11.0)	73 (89.0)	
Yes	1 (25.0)	3 (75.0)	
Antenatal corticosteroid therapy			**<0.001**
No	3 (4.8)	60 (95.2)	
Yes	7 (30.4)	16 (69.6)	
Gestational age			**0.012**
28 - 32	4 (40.0)	6 (60.0)	
33 - 36	5 (13.2)	33 (86.8)	
37 - 40	1 (2.7)	36 (97.3)	
≥41	0 (0.0)	1 (100.0)	

Continued

Mode of delivery			0.138
Vaginal	1 (3.8)	25 (96.2)	
Cesarean	9 (15.0)	51 (85.0)	

Table 3. Factors associated with newborn mortality.

Caracteristics	Evolution of newborns		p-Value
	Death (n = 10)	Alive (n = 76)	
Sex			0.178
Male	3 (7.0)	40 (93.0)	
Female	7 (16.3)	36 (83.7)	
Birth weight			**0.002**
<2500	10 (21.3)	37 (78.7)	
≥2500	0 (0.0)	39 (100.0)	
Trophicity			0.563
Eutrophic	6 (10.9)	49 (89.1)	
Harmonious IUGR	2 (22.2)	7 (77.8)	
Dysharmonious IUGR	2 (9.1)	20 (90.9)	
Apgar at 5 min			0.215
<7	8 (10.3)	70 (89.7)	
≥7	2 (25.0)	6 (75.0)	
Resuscitation			**<0.001**
No	2 (3.5)	55 (96.5)	
Yes	8 (27.6)	21 (72.4)	
Transfer to neonatology			**0.031**
No	0 (0.0)	25 (100.0)	
Yes	10 (16.4)	51 (83.6)	
RDS			0.211
No	5 (8.6)	53 (91.4)	
Yes	5 (17.9)	23 (82.1)	
IUGR			0.458
No	10 (12.2)	72 (87.8)	
Yes	0 (0.0)	4 (100.0)	
Prematurity			0.076
No	4 (7.1)	52 (92.9)	
Yes	6 (20.0)	24 (80.0)	

Continued

Asphyxia			0.233
No	9 (10.8)	74 (89.2)	
Yes	1 (33.3)	2 (66.7)	
Maternofoetal infection			0.939
No	8 (11.8)	60 (88.2)	
Yes	2 (11.1)	16 (88.9)	

Table 4. Association between acidosis, complications and neonatal mortality.

Characteristics	Evolution of newborns		p-Value
	Death (n = 10)	Alive (n = 76)	
Type of acidosis			0.209
Normal	0 (0.0)	5 (100.0)	
Metabolic acidosis	4 (13.8)	25 (86.2)	
Respiratory acidosis	1 (3.6)	27 (96.4)	
Mixed acidosis	5 (20.8)	19 (79.2)	
Ph ≤ 7.20			0.113
No	4 (7.4)	50 (92.6)	
Yes	6 (18.8)	26 (81.3)	
Complications			**<0.001**
No	1 (1.9)	52 (98.1)	
Yes	9 (27.3)	24 (72.7)	
Type of complications	n = 9	n = 24	**<0.001**
Icterus	0 (0.0)	14 (100.0)	
Neonatal infection	5 (35.7)	9 (64.3)	
Enterocolitis	3 (100.0)	0 (0.0)	
Anemia	1 (100.0)	0 (0.0)	
Respiratory distress	0 (0.0)	1 (100.0)	
Duration of hospital stay			0.079
<7	7 (17.9)	32 (82.1)	
7 - 14	0 (0.0)	26 (100.0)	
>14	3 (14.3)	18 (85.7)	

Table 5. Association between respiratory distress, resuscitation, Apgar score at 5th minute and pH ≤ 7.20.

Characteristics	pH ≤ 7.20		p-Value
	No	Yes	
Respiratory distress			**<0.001**
No	41 (78.8)	11 (21.2)	

Continued

Yes	13 (38.2)	21 (61.8)	
Total	54 (62.8)	32 (37.2)	
Notion of resuscitation			0.001
No	46 (80.7)	11 (19.3)	
Yes	8 (27.6)	21 (72.4)	
Total	54 (62.8)	32 (37.2)	
Apgar 5th minute			**0.020**
<7	2 (25.0)	6 (75.0)	
≥7	52 (66.7)	26 (33.3)	
Total	54 (62.8)	32 (37.2)	

1.82 - 40.50; p = 0.007), transfer to neonatology (HR = 7.05; 95% CI: 1.34 - 10.45; p < 0.001) and the presence of newborn complications (HR = 16.01; 95% CI: 2.02 - 126.53; p = 0.009) (Table 6).

4. Discussion

4.1. Paraclinical Examinations

We found metabolic acidosis in 33.7% of cases, respiratory acidosis in 32.6% and mixed acidosis in 27.9%. Lactate levels were below 8 in 89.5% of cases and pH ≤ 7.20 in 37.2%.

Pregnancy-related pathologies, such as hypertension, pre-eclampsia or gestational diabetes, are recognized as risk factors for acidosis. Hypertension and pre-eclampsia in particular, because they are vascular pathologies, lead to a reduction in maternal-fetal exchanges, resulting in chronic hypoxia. Fetal acidemia is a major cause of neonatal morbidity and mortality, resulting from an acute or progressive imbalance between inadequate oxygen supply and increased fetal metabolic demand [5] [6] [7].

Our results are similar for some and different for others, which is explained by the fact that in our study we have newborns with asphyxia and without asphyxia, others premature and others full-term, … with different metabolisms.

4.2. Classification of Hypertension, Delivery and Complications in Mothers versus Neonatal Outcome

Neonatal prognosis is related to gestational age at birth and to possible intrauterine growth retardation. All neonates who died as a result of prematurity had IUGR below the 3rd percentile. The mean gestational age at delivery was 25 SA and 6 days [8].

In Pakistan, 41 (45.6%) births were preterm, and 19 (21.1%) of these preterm babies were born between 34 and <37 weeks. Six (6.67%) babies were born extremely preterm. There were 10 (11.1%) neonatal deaths, of which four (4.45%) were due to low birth weight [9].

Table 6. Cox regression of factors associated with newborn death.

Characteristics	Haz. Ratios (IC à 95%)	p-Value
History of abortion		
No	1 (reference)	
Yes	2.73 (1.79 - 9.46)	0.025
Prenatal consultation		
<4	2.96 (1.45 - 3.55)	0.011
≥4	1 (reference)	
Antenatal corticosteroid therapy		
No	1 (reference)	
Yes	7.11 (1.83 - 27.53)	0.005
Term of pregnancy		
Yes	1 (reference)	
No	7.19 (1.91 - 56.78)	0.047
Sex of newborns		
Masculin	1 (reference)	
Féminin	2.38 (0.61 - 9.23)	0.207
Birth weight (grams)		
<2500	8.63 (2.45 - 14.56)	<0.001
≥2500	1 (reference)	
Trophicity		
Eutrophic	1 (reference)	
IUGR	1.24 (0.35 - 4.42)	0.731
Newborn resuscitation		
No	1 (reference)	
Yes	8.59 (1.82 - 40.50)	0.007
Transfer to neonatology		
No	1 (reference)	
Yes	7.05 (1.34 - 10.45)	<0.001
Complication		
No	1 (reference)	
Yes	16.01 (2.02 - 126.53)	0.009

In the USA, the risk of preterm birth was higher in newborns of mothers with pre-eclampsia (OR: 2.22, 95% CI: 2.00 - 2.45) and superadded pre-eclampsia (OR: 5.37, 95% CI: 4.29 - 6.73) than in those without hypertension. This risk was

not significant in women with gestational hypertension (OR: 0.97, 95% CI: 0.88 - 1.08) and slightly higher in mothers with chronic hypertension (OR: 1.19, 95% CI: 1.01 - 1.41). Among neonatal morbidities, the risk of sepsis, respiratory distress syndrome and low birth weight was higher the more severe the hypertension compared to the absence of hypertension, with the highest risks observed in children born to mothers with superadded preeclampsia (OR: 3.67, 95% CI: 2.41 - 5.59; OR: 4.19, 95% CI: 3.38 - 5.18; and OR: 9.61, 95% CI: 7.72 - 11.96, for each outcome, respectively). All types of hypertensive disorders had a significantly higher risk of these pathologies, with the exception of gestational hypertension, which only had a higher risk of respiratory distress syndrome (not sepsis or low birth weight) [10].

The risk of perinatal mortality is increased overall in cases of PE, with a relative risk of 3 to 4 for severe PE. This risk applies to all hypotrophic fetuses, whatever the nature of the gravidic hypertension (PE and other pregnancy-induced hypertensions); mortality is not increased in cases of gravidic hypertension for eutrophic fetuses. The risk is maximal (RR = 15) for hypotrophic fetuses in the context of severe PE [11].

In Australia, the neonatal mortality rate for newborns of women with eclampsia was 22.3/1000 and 10.7/1000 for infants of women with pre-eclampsia, compared with 7.9/1000 for the normotensive cohort [12].

TIAN found that the risks of neonatal RDS, pneumonia and low Apgar score were higher in women with maternal hypertension and pre-eclampsia, and that the risk tended to increase with the progression of maternal hypertension. The increased risk of neonatal respiratory disorders was observed not only in premature infants, but also in term newborns [13].

Maternal complications of gestational hypertensive (GH) are responsible for a higher rate of fetal mortality (27.5%), neonatal mortality (10%) and perinatal asphyxia (28.8%) than in uncomplicated GH. The same applies to prematurity and hypotrophy rates, which are higher in cases of maternal complications of GH and pre-eclampsia, the difference is statistically significant ($p < 0.05$) [14].

A study of pregnant women diagnosed with hypertensive syndromes had an elevated risk of having a newborn baby with an APGAR index of less than seven at one (RR = 2.33, $p < 0.001$) and five minutes (RR = 2.96, $p = 0.003$), characterized by fetal hypoxia; in addition to a higher relative risk of prematurity (RR = 2. 06, $p = 0.017$), low birth weight (RR = 2.33, $p = 0.009$), fetal death (RR = 2.36, $p = 0.03$) and Caesarean section with adverse outcome (RR = 4.41, $p < 0.001$) [1].

One third (52, 31.7%) of women experienced maternal complications, 32 (19.5%) of whom progressed to severe preeclampsia. There were two maternal deaths (1.22%). Thirty-two (19.5%) of the women gave birth before 37 weeks. Twenty-two (12.5%) of the newborns had a birth weight of less than 2.5 kg. Sixty (36.6%) newborns were admitted to the neonatal intensive care unit. There were three (1.7%) stillbirths and four (2.27%) early neonatal deaths. The perinatal mortality rate was 4.26% (42.6/1000). Five (71%) of the perinatal deaths oc-

curred during preterm birth [15].

Our results show statistically significant associations between gestational age, antenatal corticosteroid therapy and neonatal mortality, with values of ($p < 0.05$). The majority of newborns were premature and received antenatal corticosteroids. Prematurity, with its infectious and respiratory complications, is one of the main causes of neonatal mortality.

We found no significant associations between the mode of delivery, Acute Renal Failure, eclampsia, class of hypertension and neonatal outcome ($p > 0.05$).

4.3. Factors Associated with Neonatal Mortality

We found statistically significant associations between low birth weight, the notion of resuscitation, transfer to neonatology and poor neonatal outcome ($p < 0.005$).

There were no statistical associations between newborn sex, trophicity, Apgar at 5 minutes, respiratory distress, IUGR, prematurity and outcome ($p > 0.05$).

Three variables were significantly associated with neonatal death: the mother's medical history ($p = 0.000$), mode of delivery ($p = 0.000$) and gestational age ($p = 0.001$). Newborns whose mothers had a medical history of hypertension (20.5%), IUFD (78.9%) and other pathologies (5.4%) were associated with neonatal death. In addition, more than a third (39.0%) of vaginal births and almost a quarter (20.6%) of preterm newborns were significantly associated with neonatal death [16].

Statistical tests such as the Chi-2 or Fisher tests showed that the following factors were associated with mortality: birth weight below 1.5 kg ($p = 0.011$), persistence of ducts arteriosus ($p = 0.047$), failure to take antenatal corticosteroid therapy ($p = 0.003$). Several factors linked to mortality have been reported in the literature, including: hypotrophy, prematuritý, vaginal delivery, early PE [17].

Early neonatal admission, provenance from another maternity hospital, breech presentation, gestational age less than 32 weeks, birth weight less than 1500 g, significantly influenced newborn mortality. Neonatal infections, adaptation disorders and encephalopathy, prematurity and malaria were significantly associated with death. Single mother status and fewer than 4 antenatal visits had a significant influence on death [18].

Low birth weight (16.1%), low APGAR score (13.4%), IUGR (5.4%), premature delivery (13.4%) and birth asphyxia (12.5%) were other causes of unfavorable perinatal outcomes, each lower than the studies carried out at the Mettu Karl referral hospital (low birth weight 30.5%, low APGAR score 18. 5%, and preterm delivery 31.4%), Debre Berhan Referral Hospital, Ethiopia (39.4% low birth weight, 38.4% low APGAR score and 8.5% IUGR) and Iran (52.6% prematurity, 9.9% IUGR and 17.3% low birth weight) [19].

The data in the literature concur with our own, but with some percentage differences. This would depend on the quality of obstetric and neonatal care in each country.

4.4. Association between Acidosis, Complications and Neonatal Mortality

A statistically significant association between the presence of complications in neonates and their outcome ($p < 0.001$) was found in our study. Type of acidosis, PH and length of hospital stay were not statistically associated with neonatal outcome ($p > 0.05$).

In contrast to our study, MALIN et al carried out a systematic review and meta-analysis of the association between umbilical cord pH and perinatal and long-term outcomes. They found an association between low cord arterial pH and neonatal mortality, anoxic ischemic encephalopathy (AIE), intraventricular hemorrhage, periventricular leukomalacia and cerebral palsy. However, the variable and threshold used to define significant acidosis differed considerably from one article to another, and the population varied, including both full-term and preterm infants [20]. This would be explained by the difference in sample size in the two studies.

Complications found in our study were jaundice and neonatal infections; resistance of hospital-acquired germs to antibiotics would explain this mortality.

4.5. Association between Respiratory Distress, Resuscitation, Apgar Score at 5th Minute and pH ≤ 7.20

According to our results, respiratory distress, resuscitation and Apgar score at 5th minute are statistically associated with pH ≤ 7.20.

It has recently been shown that umbilical artery pH levels below 7.20 are associated with an increased risk of neonatal morbidity, including respiratory distress and sepsis [21].

A low Apgar score is an important indicator of neonatal respiratory function, and previous studies have shown that gestational hypertension and preeclampsia were associated with low Apgar scores at 1 min and 5 min [13].

Rates of metabolic acidosis generally decrease with increasing Apgar score values. For the 1-minute Apgar score, there is a steady decrease in metabolic acidosis rates between Apgar 0 (35%) and Apgar 10 (0%). For Apgar scores at 5 and 10 minutes, the decrease was constant for Apgar score values from 6 to 10. For Apgar scores of 0 to 3 at 1, 5 or 10 minutes, rates of metabolic acidosis (using pH threshold < 7.05) ranged from 13% to 50% [22].

In the KRO study, when neonates had moderate acidosis, a low pCO2 value measured at cord blood was associated with a lower Apgar score at 5 minutes of life than when the pCO2 value was above the median for the cord blood sample (arterial or venous pH) studied [5].

4.6. Cox Regression of Factors Associated with Neonatal Death

We found that the risk of newborn death was associated with:

- History of maternal abortion, with a risk multiplied by (HR = 2.73; 95% CI: 1.79 - 9.46; p = 0.025),

- No prenatal consultation during pregnancy (HR = 2.96; 95% CI: 1.45 - 3.55; p = 0.011),
- Antenatal corticosteroid therapy (HZ = 7.11; 95% CI: 1.83 - 27.53; p = 0.005),
- Prematurity (HZ = 7.19; 95% CI: 1.91 - 56.78; p = 0.047),
- Low birth weight (HR = 8.63; 95% CI: 2.45 - 14.56; p < 0.001),
- Neonatal ressuscitation (HR = 8.59; 95% CI: 1.82 - 40.50; p = 0.007),
- Transfer to neonatology (HR = 7.05; 95% CI: 1.34 - 10.45; p < 0.001) and
- The presence of newborn complications (HR = 16.01; 95% CI: 2.02 - 126.53; p = 0.009).

Hypertensive disorders of pregnancy are a group of placental diseases. In severe cases, placental function is affected, leading to fetal growth retardation, fetal intrauterine distress, premature birth, intrauterine death and stillbirth. It is one of the main causes of perinatal death [23].

Neonatal mortality is significantly associated with low birth weight and prematurity [24].

The MUHE study revealed that only a few conditions contributed to the majority of premature deaths. Respiratory distress syndrome alone contributed to 45% of primary causes of premature death. Sepsis, meningitis and pneumonia combined contributed to almost 30% of primary causes of premature death, followed by asphyxia, which contributed to around 14% of deaths. Hypothermia was the most common cause of death, accounting for 69% of all deaths [25].

Three variables were significantly associated with neonatal death: maternal medical history (p = 0.000), mode of delivery (p = 0.000) and gestational age (p = 0.001) [16]. In our study, a history of abortion doubled the risk of death. The mother's medical history can lead to complications during pregnancy and increase the risk of perinatal mortality.

The use of antenatal corticosteroids in excess of 70% in both groups reflects obstetric care; the benefits of this therapy are described in the literature under aspects such as reduced risk of neonatal death, occurrence of respiratory distress syndrome and intraventricular hemorrhage [3].

In contrast, DESHMUKH results indicate that antenatal corticosteroid exposure was associated with a significant reduction in mortality and severe intraventricular hemorrhage (IVH) and periventricular leukomalacia (PVLM) in neonates born at less than 25 weeks gestation. The effects of corticotherapy were consistent, with no significant difference in neonatal mortality between 22, 23 and 24 weeks. The benefit for severe IVH/PVLM was only significant for neonates born at 24 weeks [26]. In our study, corticosteroid therapy was not the cause of mortality, but rather prematurity, which was frequent and required pulmonary maturation before induction of delivery.

Gestation at the time of admission was the variable most strongly associated with perinatal death (AUROC = 0.81, 95% CI = 0.77 - 0.84), early gestation being strongly associated with perinatal death. Between 26 and 27 completed weeks of gestation, the risk of perinatal death was 50%; from 32 weeks of gestation, the risk of perinatal death was approximately ≤ 10% [27].

In the final multivariable analysis, women with preeclampsia/eclampsia had a significantly higher risk of caesarean section (57.0% vs. 42.4%; adjusted RR, 1.37; 95% CI, 1.01 - 1.87; p = 0.04), preterm delivery at < 34 weeks' gestation (21.3% vs. 6.5%; adjusted RR, 2.74; 95% CI, 1.40 - 5.36; p = 0.003) as well as preterm delivery at < 37 weeks' gestation (40.7% vs. 21.3%; adjusted RR, 1.89; 95% CI, 1.25 - 2.85; p = 0.002), compared to women with chronic/gestational hypertension. NICU admission (30.7% vs. 19.8%) and perinatal mortality (23.5% vs. 11.2%) were significantly higher in women with pre-eclampsia/eclampsia in the univariable analysis [28].

Women with preterm birth had an increased risk of adverse neonatal outcomes. This finding is similar to that made by other researchers. Khashu and colleagues studied the perinatal outcomes associated with preterm birth between 33 and 36 weeks' gestation and found that perinatal mortality was 8 times higher, neonatal mortality 5.5 times higher and respiratory morbidity 4.4 times higher in preterm babies than in full-term babies. Similarly, Young and colleagues studied mortality in late preterm infants and found that the neonatal mortality rate was higher in preterm babies than in full-term babies [29]. These results are similar to our own, given that prematurity, with its multiple early complications, increases neonatal mortality, especially in developing countries.

The weight of newborns born to PE mothers was significantly lower than that of non-PE newborns (1150 g vs. 1430 g, p < 0.001). PE babies were more often hypotrophic at birth than non-PE babies (22% vs. 9%, p < 0.001). Perinatal mortality (13% vs. 7%, p = 0.03). Using logistic regression analysis, the odds ratio for perinatal mortality was 2.038 (95% CI: 1.06 - 3.92) comparing the PE group with control cases, and the odds ratio for infant mortality was 1.962 (95% CI: 1.06 - 3.62). Fifteen newborns died in the PE group, thirteen within the first 28 days after delivery [30].

The birth weight of the newborn is strongly associated with the risk of mortality in the first year and, to a lesser extent, with developmental problems and the risk of various diseases in adulthood [31].

PE significantly increased the risk of adverse outcomes, including caesarean section (AOR = 2.2), placental abruption (AOR = 3.3), low birth weight (AOR = 2.8), preterm delivery (AOR = 7.1) and a 5-minute Apgar score < 7 (AOR = 2.4). Gestational hypertension significantly increased the risk of preterm delivery (AOR = 1.8) [32].

Fetal outcome was studied in terms of birth weight, Apgar score and need for transfer to a neonatal hospital unit. Thus, 74% of newborns had a low birth weight, of which 70% were premature. The proportion of low birth weight and prematurity had a statistically significant association with the amount of protein in the urine. 58% of newborns required transfer to the neonatal hospitalization unit after birth. Perinatal mortality was 23% [33]. Low birth weight alone is a factor in neonatal death; associated with the neonatal complications of HDP, the risk of mortality increases. Poorly organized care in the neonatal unit would expose newborns to complications, especially infectious ones, and thus explain the

high risk of mortality in the event of transfer to neonatology.

5. Conclusions

Mortality of newborns born to hypertensive mothers remains high in our setting; it is associated with a history of abortion in the mother, failure to follow up antenatal consultations, low birth weight, resuscitation in the delivery room, transfer to neonatology, gestational age and complications during hospitalization in neonatology.

The main reasons for hospitalization in neonatology were prematurity followed by respiratory distress. The latter was associated with severe acidosis.

Analysis and monitoring of pH and umbilical cord blood gases remain necessary for the decision to manage neonatal acidosis.

Prospect

Carry out a study evaluating the psychomotor development of newborns of hypertensive mothers to complement our own.

Conflicts of Interest

The authors declare no conflicts of interest.

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