

# Risk Factors of Early Neonatal Deaths in Pediatric Teaching Hospital in Bangui, Central African Republic

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## Abstract

**Background:** The neonatal mortality rate in the Central African Republic (CAR) is 42.3 per 1000 live births in 2017, indicating that CAR is with the highest number of newborn deaths. **Objective:** The objective is to clarify the risk factors of neonatal deaths in this area. **Methodology:** A case-control study with retrospective data collection. Targets were newborns >7 days, hospitalized and dead (cases), and newborns admitted after the respective case during the study period and discharged before the 7<sup>th</sup> day of life. This study was carried out between 2016 and 2018 in the neonatal unit of the “Complexe Hospitalier Universitaire Pédiatrique de Bangui” (CHUPB), the only national hospital for newborns care in the CAR. **Results:** We included 902 newborns, with 451 cases of early neonatal death and 451 controls. 4168 newborns were admitted to the neonatology unit with 621 early death cases; a lethality rate of 14.9%. Early neonatal deaths factors were: newborns with low birth weight (OR = 22.59; 95% CI [15.93 - 32.04]; P < 0.001); mothers who did not attend antenatal care (OR = 5.54; 95% CI [3.95 - 7.79]; P < 0.001), home delivery (OR = 0.70; 95% CI [0.03 - 0.15]; P < 0.001); young maternal age < 25 years (OR = 2.08; 95% CI [1.58 - 2.73]; P < 0.001); non-medical transport (OR = 2.14; 95% CI [1.03 - 4.46]; P = 0.03); origin from remote areas (OR = 5.25; 95% CI [3.95 - 6.98]; P < 0.001); isolated prematurity (P < 0.01); anoxo-ischemic encephalopathy (OR = 12.72; 95% CI [6.54 - 34.73]; P < 0.01); delivery by cesarean section (OR = 0.59; 95% CI [0.41 - 0.84]; P < 0.001); pre-

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term delivery (OR = 29.36; 95% CI [20.12 - 42.81];  $P < 0.001$ ), and maternal lower education (OR = 5.65; 95% CI [4.08 - 7.81];  $P < 0.001$ ). **Conclusion:** The early neonatal mortality rate remains high in this area. Controlling the factors mentioned above might lead to improving the survival of newborns.

## Keywords

Early Neonatal Mortality, Risk Factors, CHUPB, CAR

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## 1. Introduction

Neonatal death, including children born alive and dead between birth and the 28th day of life, is a public health concern. It is considered early death when it occurs before the first week of life [1]. It can be divided into two sub-categories: early neonatal mortality between 0 and 6 days and late neonatal mortality between 7 and 27 days [2].

According to the World Health Organization (WHO), overall neonatal deaths are 2.6 million [3]. This neonatal mortality is an indicator of obstetric and neonatal care quality which is the witness of the socio-economic development level of a country. This mortality remains 10 to 15 times higher in developing countries than in developed ones [4]. Thus, only one in 1000 dies in the first 28 days of life in Japan but, in CAR, out of 1000 babies born, 42.3 will not survive at one month of life, otherwise one in 20 newborns. This epidemiological profile data makes CAR the first in the world among low-income countries with the highest number of neonatal deaths [5]. Likewise, intra-hospital neonatal mortality is higher and varies according to the health setting. Early neonatal mortality can exceed 50% in the neonatal units in low-income countries' hospitals [6] [7]; the contributing factors are the socio-economic environment, access to care, the type of patients, the medical equipment, and human resources [7].

In sub-Saharan Africa, where the Central African Republic is located, the birth of a baby is an important and joyful social event for the family and the whole community. However, the death of a newborn is a trauma to the family for which the community often tries to find fatalistic explanations. Few data on early neonatal death in CAR are available; hence this case-control study aims to determine the frequency, clinical, and outcome characteristics and to identify the risk factors associated with early neonatal mortality at the pediatric teaching hospital of Bangui.

## 2. Methodology

The study was retrospective. It was carried out between 2016 and 2018 in the neonatal unit of the pediatric teaching hospital of Bangui, the only national hospital for newborn care in the CAR. No conventional care system and graduated patient management are operational in the current health pyramid. Barely 4% of

patients are referred from peripheral health facilities to the pediatric hospital.

The unit includes in situ diagnostic tools (pulse oximeter, transcutaneous bilirubinometer, glucometer, and urine strips), warming (radiant lamps), manual ventilation, oxygen therapy (oxygen concentrator, masks, and nasal cannula) as well, as for intravenous and umbilical infusions. Cardiorespiratory monitors, phototherapy devices, and syringe pumps are also available. Assisted ventilation and positive airways pressure at the end of expiration are not available. The skin-to-skin or kangaroo method sub-unit has 8 beds with breastfeeding support. The hospital laboratory operates 24 hours 7 days and performs biological hematologic, biochemical investigations (dosage of C-reactive protein, serum creatinine, bilirubin, and blood ionogram) and bacteriology (blood cultures, urine cultures, etc. analyzes of cerebrospinal fluid). The imaging department can perform standard radiology and ultrasound. Computed tomography is feasible in the imaging unit close to the hospital but is not free of charge. The staff members of the neonatal unit include a pediatric neonatologist, residents in pediatrics, two nursery nurses, and ten nurses. The ratio is equal to one nurse for 4.2 newborns.

The retrospective data collection included as cases: any newborn less than seven days hospitalized in the ward and died during the study period. The control group consisted of all newborns admitted to the ward immediately after their respective cases during the study period and who survived till their seventh day of life. Those who died upon arrival or after seven days of life, as well as those released alive after seven days of life, were not included. The study variables related to the mother were age, parity, quality of antenatal care, occupation, socio-economic level, education level, location, marital status, and Clinical incidents during the current gestation. Newborn variables were origin, mean of transport, reason for hospitalization, type of delivery, gestational age, sex, birth weight, hospitalization duration, clinical signs, diagnosis, treatment and outcome.

A low level of education was defined by education not exceeding elementary level or lack of education. The housewife is defined as any woman whose main occupation is to take care of the household tasks. Low birth weight is defined as a birth weight less than 2500 grams. Respiratory distress is defined as a Silverman score  $\geq 4$ . The model of appropriate antenatal care (ANC) used for this study is that of WHO 2016, with eight ANC [8]. Data was collected from the service's registers and medical records. These collected data have been kept secret for the respect of confidentiality. The data had been analyzed using Epi Info 7 software in version 7.1.3.3. The p-value  $< 0.05$  was considered significant, and the odds ratio was calculated with a 95% confidence interval.

### 3. Results

Out of 4168 newborns admitted to the neonatal department of the pediatric hospital, early death occurred in 621; a lethality of 14.90%. From one year to another

er, we observed a lethality rate of 14.41% (195/1353) in 2016, 17.12% (245/1431) in 2017, and 13.07% (181/1384) in 2018, as shown in **Figure 1**.

Among the 621 files of newborns that died early, we kept 451 files whose information could be used in accordance with the case inclusion criteria.

Likewise, out of the 2245 files of newborns survived before the 7<sup>th</sup> day, we selected 451 files whose information could be used in accordance with the case control criteria. One control was matched to each case.

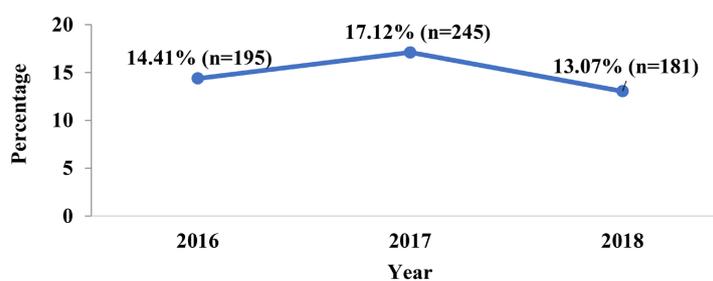
### 3.1. Maternal Characteristics and Early Neonatal Death

The mean age of the mothers in the cases group was  $22 \pm 6$  years versus  $26 \pm 5$  years for the control group's mothers ( $P < 0.001$ ). Teenager and young mothers (under 25 year-old) represented 60.53% ( $n = 546$ ), with the percentage of 57.14% ( $n = 312$ ) and 42.86% ( $n = 234$ ), respectively among cases and controls. They lived in rural areas in 68.25% ( $n = 329$ ) for the cases and 31.75% ( $n = 153$ ) for the controls ( $p < 0.001$ ) and were primiparous in 50.16% ( $n = 311$ ) for the cases versus 49.83% ( $n = 309$ ) for the controls. Among the cases, mothers have no education in 62.14% ( $n = 384$ ) versus 37.86% for controls ( $n = 234$ ). Newborns of women who did not attend antenatal care were 5 times more likely to die early (OR = 5.54 95% CI [3.95 - 7.79];  $P < 0.001$ ). About one in seven women (58.10%) with Clinical incidents during the current gestation had the risk of losing her baby early (OR = 1.4; 95% CI [1.04 - 2.10];  $P = 0.02$ ). Childbirth in a hospital was a protective factor against death (OR = 0.70; 95% CI [0.03 - 0.15];  $P < 0.001$ ). Cesarean delivery was counted among the risk factors for early neonatal death (OR = 0.59; 95% CI [0.41 - 0.84];  $P < 0.001$ ). Finally, newborns of women with lower education, were 5.65 time more likely to die (OR = 5.65; 95% CI [4.08 - 7.81];  $P < 0.001$ ). See **Table 1**.

### 3.2. Characteristics of the Newborn and Early Neonatal Death

Male sex was 48.27% ( $n = 307$ ) among cases and 51.73% ( $n = 329$ ) among controls. The sex ratio was 2.13 for cases and 2.69 for controls.

Newborns with low birth weight were 22.59 times more at risk of early neonatal death (OR = 22.59; 95% CI [15.93 - 32.04];  $P < 0.001$ ). The risk of early neonatal death was 29.36 times greater in newborns of gestational age below 37 weeks of amenorrhea based on Finnstrom score (OR = 29.36; 95% CI [20.12 - 42.81];  $P < 0.001$ ). Non-medical transport increased the risk of early neonatal



**Figure 1.** Distribution of early neonatal death by year.

**Table 1.** Relationship between early neonatal death and the characteristics of the mother.

Parameter	Death cases (N, %)	Cases controls (N, %)	OR	P
<b>Mothers age (in year)</b>				
< 25 (n = 546)	312 (57.14)	234 (42.86)	2.08 [1.58 - 2.73]	<0.01
≥ 25 (n = 356)	139 (39.05)	217 (60.95)		
<b>Location</b>				
Rural (n = 482)	329 (68.25)	153 (31.75)	5.25 [3.95 - 6.98]	<0.01
Urban (n = 420)	122 (29.1)	298 (70.9)		
<b>Marital status</b>				
Singles (n = 521)	250 (47.98)	271 (52.02)	0.82 [0.63 - 1.07]	0.07
Married (n = 381)	201 (52.75)	180 (47.25)		
<b>Education level</b>				
No education (n = 618)	384 (62.14)	234 (37.86)	5.65 [4.08 - 7.81]	<0.01
Educateds (n = 280)	63 (22.50)	217 (77.50)		
<b>Profession</b>				
Paid employment (n = 72)	33 (45.83)	39 (54.17)	0.83 [0.5 - 1.35]	0.23
Other Jobs (n = 830)	418 (50.36)	412 (49.64)		
<b>Parity</b>				
Primiparous (n = 620)	311 (50.16)	309 (49.84)	1.02 [0.77 - 1.35]	0.88
Multiparous (n = 282)	140 (49.64)	142 (50.36)		
<b>Antenatal care well followed</b>				
No (n = 248)	194 (78.22)	54 (21.78)	5.54 [3.95 - 7.79]	<0.01
Yes (n = 654)	257 (39.29)	397 (60.71)		
<b>Delivery place</b>				
Hospital (n = 805)	362 (44.96)	443 (55.04)	0.70 [0.03 - 0.15]	<0.01
Home (n = 97)	89 (91.75)	8 (8.25)		
<b>Type of delivery</b>				
Vaginal (n = 747)	357 (47.79)	390 (52.21)	0.59 [0.41 - 0.84]	<0.01
Cesarian section (n = 155)	94 (60.64)	61 (39.36)		
<b>Clinical incidents during the current gestation</b>				
Yes (n = 155)	90 (58.10)	65 (41.90)	1.4 [1.04 - 2.10]	0.02
No (n = 747)	361 (48.33)	386 (51.67)		

death by 2.14 (OR = 2.14; 95% CI [1.03 - 4.46]; P = 0.03). The risk of early neonatal death was 12.72 times in anoxic ischemic encephalopathy (OR = 12.72; 95% CI [6.54 - 24.73]; P < 0.001). Congenital malformations increased the risk of

early neonatal death by 1.2, but the link was not statistically significant (OR = 1.2; 95% CI [0.36 - 3.96]; P = 0.09). See **Table 2**.

**Table 2.** Relationship between early neonatal death and newborn characteristics.

Parameters	Death cases N (%)	Case control N (%)	OR	P
<b>Sex</b>				
Male (n = 636)	307 (48.27)	329 (51.73)	0.79 [0.5 - 1.05]	0.10
Female (n = 266)	144 (54.14)	122 (45.86)		
<b>Gestationnal age (in week)</b>				
<37 (n = 390)	345 (88.46)	45 (11.54)	29.36 [20.12 - 42.81]	<0.01
≥37 (n = 512)	106 (20.70)	406 (79.30)		
<b>Weight (in grams)</b>				
<2500 (n = 487)	389 (79.87)	98 (20.13)	22.59 [15.93 - 32.04]	<0.01
≥2500 (n = 415)	62 (14.94)	353 (85.06)		
<b>Transportation means</b>				
Non médicalisé (n = 868)	440 (50.7)	428 (49.3)	2.14 [1.03 - 4.46]	0.03
Médicalisé (n = 34)	11 (32.35)	23 (67.65)		
<b>Diagnosis at time of death</b>				
<b>Prematurity with complication</b>				
Yes (n = 184)	150 (81.53)	34 (18.47)	6.11 [4.09 - 9.12]	<0.01
No (n = 718)	301 (41.9)	417 (58.1)		
<b>Prematurity without complication</b>				
Yes (n = 142)	0 (00)	142 (100)	-----	<0.01
No (n = 760)	451 (59.4)	309 (40.6)		
<b>Neonatal distress respiratory</b>				
Yes (n = 191)	103 (53.92)	88 (46.08)	1.22 [0.88 - 1.68]	0.22
No (n = 711)	348 (48.9)	363 (51.1)		
<b>Encephalopathy anoxo-ischémia</b>				
Yes (n = 111)	101 (90.99)	10 (9.01)	12.72 [6.54 - 24.73]	<0.01
No (n = 791)	350 (44.3)	441 (55.7)		
<b>Neonatal infection</b>				
Yes (n = 253)	85 (33.59)	168 (66.40)	0.39 [15.93 - 32.04]	<0.01
No (n = 649)	366 (33.6)	283 (66.4)		
<b>Congenital malformation</b>				
Yes (n = 11)	6 (54.54)	5 (45.46)	1.2 [0.36 - 3.96]	0.09
No (n = 891)	445 (49.9)	446 (50.1)		

**Continued****Jaundice encephalopathy**

Yes (n = 3)	2 (66.6)	1 (33.4)	2 [0.18 - 22.18]	0.56
No (n = 899)	449 (49.9)	450 (50.1)		

**Neonatal Tetanus**

Yes (n = 3)	2 (66.6)	1 (33.4)	2 [0.18 - 22.18]	0.56
No (n = 899)	449 (49.9)	450 (50.1)		

**Hemorrhagic disease of newborns**

Yes (n = 2)	2 (100)	0 (00)	-----	0.15
No (n = 900)	449 (49.88)	451 (50.2)		

**4. Discussion**

The present study focused on newborns managed in a neonatal unit of the only national referral hospital center, which receives approximately 95% of births with problems in Bangui and its surroundings. These newborns already have a higher risk of mortality compared to healthy newborns. Thus, the results obtained remain valid for the framework of the study and do not reflect the situation in the general population where the neonatal mortality rate is 42.3 deaths per 1000 live births [3]. Under the conditions of hospital care in Bangui, Bobossi in 1999 reported the result of a pediatric intervention in the delivery room for newborns requiring intensive care. The hospital mortality rate was 9.7% [9]. In 2003, the latter observed this time, at the Pediatric hospital—the only pediatric unit in the Central African Republic geographically separated from maternity hospitals—overall intra-hospital mortality of around 28.4% [10]. By applying the 2/3 rule according to Lawn [11], we would have an early intra-hospital mortality rate of about 18.9% in 2003, close to the trend observed in 2017. These comparisons show a fluctuation in the rate of early intra-hospital mortality from 13.07% to 18.9%, clearly superior to the results obtained in the first hours after resuscitation in the maternity ward of the Bangui Community Hospital in 1999 (9.7%).

It was a pilot project that was never carried out. According to this analysis, it is more than urgent to reduce external transfer by creating neonatal units in the referral maternities in Bangui; waiting for decentralization in the different health regions of the country. The low mortality in facilities caring for mother and newborn is a reality confirmed by the observations of Kedy in Douala with 6.6% [12], Garba in Niamey with 6.31% [13], Manzar in Pakistan with 6.39% [14], and Baker in New York with 1.9 per 1000; materializing both the protective aspect of in situ interventions for the newborn and the quality of care in developed countries [15]. The difference in care observed, between developed and developing countries, for hospitals with neonatal intensive care units as well as in health systems where referral to tertiary care is possible, reveals the lack of interventions upstream of maternity hospitals and pediatric units to prevent obstetric

complications [16] [17] [18].

For the Central African Republic, during the study period, the lack of antenatal and pre-natal interventions would be partly induced by armed conflicts. Indeed, in addition to the conflicts responsible for the decline in the use of services, the weak contribution of the State to health expenditure previously prevented the development of the health system in a context where the population—mostly poor—struggled to access care [19]. Thus, with free care, already effective in the pediatric unit, it is necessary to combine the optimization of pregnancy monitoring and the organization of timely transfers of parturients to obstetric referral centers to reduce the cause of the obstetric complications of neonatal deaths [20] [21]; waiting for the end of armed conflicts and the increase in the financial contribution of the State to health care.

#### **4.1. About the Relationship between Early Neonatal Death and Maternal Characteristics**

For maternal factors, our results showed that parturients under 25-year-old, primiparous, and not attending school are the most affected by early neonatal deaths. This observation was made by Blondel in France [22] and could be explained, among others, by the fact that in CAR, sexual activities are precocious, in particular with unwanted pregnancies: a source of inappropriate follow-up; negatively impacting the quality of antenatal and post-natal. The data from our work supported observations on the barriers to accessing pregnancy follow-up [23]. Thus, the lack of prenatal consultation, multiplying by 5.54 the risk of death of the newborn, is usual [7] [24] [25] [26] [27]. For Garba in Niger, mothers who have had a good ANC are 3.72 times less likely to see their child die [13]. Like poor pregnancy follow-up, rural origin increases the risk of early neonatal death. This has been reported in several studies suggesting the geographic barrier and/or life in rural areas as risk factors for neonatal death [25] [28] [29].

Contrary to the majority of studies that consider the cesarean section as a protective factor of early neonatal death and would even make it possible to avoid perinatal mortality by 71% [30], in our study; this mode of delivery is linked to the risk of early neonatal death. This observation, which corroborates Akinyemi's observations [21], would be because cesarean sections are often indicated in our maternity hospitals for maternal rescue or acute fetal suffering; exposing them to the risk of induced prematurity and neonatal asphyxia; so many clinical situations unfavorable to the survival of the newborn.

#### **4.2. About the Relationship between the Early Neonatal Death and Newborn Characteristics**

In our study, most newborns are male, of low birth weight, and for most of the time, born before 37 weeks of gestation in respiratory distress and transported to the pediatric unit by non-medical transportation. This male predominance does not influence the occurrence of early neonatal deaths, unlike observations showing the male sex as a risk factor for neonatal mortality [31] [32] [33] [34] [35]. The

factors that cause early neonatal mortality are preterm delivery, low birth weight, and inappropriate transport. Neonatal infection, anoxo-ischemic encephalopathy (EAI), and congenital malformations are the most observed neonatal pathologies.

In our series, the first day of life is the deadliest of the neonatal period with a proportion of 85.15% ( $n = 367$ ); obeying the two-thirds rule of deaths occurring within 24 hours of birth, reported by several authors [10] [11] [36]. Considering the risk factors of early lethality, prematurity, being the primary goal of antenatal consultations, has been shown to be the first direct cause of early neonatal mortality. This does not seem surprising, taking into account many factors—providers of prematurity and its consequences—present in the Central African Republic and described elsewhere linked to the low socio-economic level, insufficient medical follow-up of pregnancy, early motherhood, childbearing, long journeys, and inappropriate means of transport [37] [38] [39]. But this predominance of prematurity is not particular to developing countries [40] [41]. Regarding selection bias for prematurity and hypotrophic infants, there are often difficulties in estimating gestational age (ignorance of the date of the last menstruation, absence of early ultrasound) [42]. But, a careful clinical examination (Finnstrom score) allowed us most often to differentiate between the true premature and the hypotrophic newborn. Anyway, newborns with low birth weight have 22.59 times more risk of dying than those with normal birth weight. Several authors in Africa [24] [25] [43] [44] [45] [46] [47] and in Asia [48] [49] have reported the same findings. The main thing is to observe that most children with low birth weight are not preterm—that they have in common problems of growth in utero, generally due to the poor health of their mother [50] in order to intervene upstream on the health problems of women of childbearing age.

Regarding the pathologies found in early deaths newborns in our series, malformations are major contributors, followed by anoxo-ischemic encephalopathy, infections, and respiratory distress. Infections, prematurity, and brain injury are frequently cited causes of neonatal mortality in Africa, varying in their proportion from one site to another [51] [52]. According to Lawn [53], worldwide in 2012, the clinical situations frequently associated with neonatal mortality are complications of prematurity (0.99 million, 34%), perinatal asphyxia (0.72 million, 25%), and infections (including sepsis, meningitis, and pneumonia; 0.64 million, 22%). It is also reported in Lawn's systematic review that complications of preterm delivery have similar proportions in countries with low mortality and high mortality. However, poor management of preterm newborns is observed in most countries with high mortality. Yenan [54] pointed out the limits of human and material resources in newborn care management in Bouaké. Azaria [40] underlines that “in addition to the organization of societies around access to care and the influence of modes of solidarity on the national health of people in precarious situations, also include ethnic differences or geographical, educational level and territorial inequalities” and proposes to take into account while analyzing. Thus, we have to recognize that national solidarity, through free health

care offered to children in the Central African Republic, is far from solving the problems of neonatal morbidity and mortality. It seems like this system generates the inadequacy between need and offer as human and material resources are lacking, given the realities revealed by Yenani *et al.* [54]. If we refer to the study on the nurse's workload carried out in 2002 by Aitken, the patient/nurse ratio is not blamed [55]. The workload of the pediatrician likely remains to be blamed at the pediatric hospital. Indeed, the standards of practice in the neonatal hospitalization unit require the presence of a pediatrician 24 hours 7 days skilled in neonatal resuscitation [56]; whereas in our case, the pediatrician—with this skill—provides care in the unit for 8 hours out of the 24 required.

Our observation concerning the strong implication of congenital malformations is supported by the assertions that a gradient between the risks of congenital anomaly increase as the precariousness index increases [57].

## 5. Conclusions

This study, limited to the only referral neonatal unit in the Central African Republic, showed determinants of early neonatal mortality often observed in countries with high mortality is related to the young age of the mother, the poor antenatal care, rural area, cesarean section, gestational age < 37 weeks, weight < 2500 g, external transfer, infections, perinatal asphyxia, congenital abnormalities, and respiratory distress.

The literature review has shown us that beyond national solidarity targeting the most vulnerable in the form of free healthcare implementation at the neonatal unit in Bangui, it would be necessary to decentralize the care of pregnant women and newborns, facilitate access to education for mothers and improve the offer/need ratio in response strategies aiming to increase newborn survival in the Central African Republic.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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