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# Predictors of Survival of Preterm Newborns Admitted in Neonatology Unit at University the Teaching Hospital of Butare, Rwanda

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## ABSTRACT

**Introduction:** Preterm delivery is a global challenge and we are still observing deaths from preterm newborns in developing counties including Rwanda. There is paucity of data about predictors of survival (defined as being discharged alive from the study hospital) of preterm newborns in Rwanda and no data available for referral hospitals.
This study was aimed to determine survival of preterm newborns and its predictors in neonatology unit of University Teaching Hospital, a referral hospital in Rwanda.
**Methods**: This was a cross-sectional study using quantitative methods. Data were collected during one-year period since July 2019 till June 2020, 401 participants have been admitted during the study period, and 17 participants have been excluded due to missing data. Data have been entered into excel, then imported into SPSS version 27. Descriptive statistics has been done by computing prevalence, binary and then multiple logistic regression has been used to assess the predictors of survival, the significance of predictors was reported with adjusted odd ratio and p value less than 0.05 was considered as statistically significant.
**Results**: Survival of preterm newborns was 96%. Gestational age and crying immediately at birth were significantly associated with survival of preterm newborns (p= 0.004). Crying immediately at birth were significantly associated with survival of preterm newborns (p= 0.001), and time to death (aHR: 0.09, 95% CI: 0.02-0.37, p<0.001). Number of antenatal care (ANC) visits significantly associated with time to death (aHR: 0.22, 95% CI: 0.06-0.78, p=0.02).
**Conclusion**: These findings show a high survival rate and identified gestational age, crying at birth, and ANC visits as the predictors of survival and time to death. Therefore, measures and strategies targeting these predictors, involving CHUB leadership and partners are recommended.

## INTRODUCTION

Preterm birth, defined as the delivery of an infant before 37 completed weeks of gestation, is a significant public health concern worldwide [1]. Even though the preterm survival rate has improved in developed countries, neonates are still dying in developing countries as mostly result of inadequate maternal and newborn care [2]. The recent global estimate revealed that PTB counted

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10.6% of global live birth in 2014, giving an estimate of 14.84 million preterm births globally. The figures show that the cases of preterm have been on an increase ever since 2000 up to 2014, whereby the Asia region only counted more than half (52.9%) of the global preterm birth proportion [2]. Evidence shows that 1 in 10 babies are born before the term [3]. PTB was ranged the first among the three top leading mortality causes in infants below the age of five (15.9%) in the estimate between 2000 – 2015 for 194 countries [4]. Globally, over 15 million newborns with an estimated 11% of all deliveries were recorded [5], and 1 million of them die annually, even those who survive face life-threatening disability as well as learning, visual and hearing problems. Yet, three quarters of deaths could be prevented through the current cost-effective care [6].

Developing countries are the most affected, 81.1% (12.0 million) happened in Asia and Sub-Saharan Africa in 2014 and five countries (India, China, Nigeria, and Indonesia) counted 44.6% of the global preterm birth babies in 2014 [2]. Prematurity occurs more in developing countries compared to developed countries 12% against 9% of babies are born before term [4].

Furthermore, [2], reported that in 2014 babies born in Africa represented 13.4% and 8.7% in Europe. The findings from the estimate from 194 countries between 2000 and 2015 showed that prematurity was classified as the number two main cause of infant death in Sub-Saharan Africa. Preterm birth counted 13% of death in children under five years. Three countries in Africa namely Nigeria, Ethiopia, and Tanzania were classified among the global top then countries with a high number of preterm birth in 2014 [2].

Survival of preterm babies varies considerably by geographic region and the level of income - whereby in low-income countries only less than 10% of preterm babies die. Again, for babies born at or less than 32 weeks in low-income countries, only a half of them survive resulting from lacking practicable, cost-effective essential care to preterm babies such as warming, support in breastfeeding, prevention and management of infection, and breathing support. Contrary similar babies born in high-income countries almost all of them survive [7]. While the rate of preterm birth was estimated to be 16.6% in Tanzania and 12% in Ethiopia [2], PTB in Rwanda is estimated to be 10% and roughly 35,000 preterm babies are born each year [8], similar findings were reported by [9] in a survey carried out within Kigali and prevalence of preterm birth was 10.1%. Neonatal illnesses constitute the first cause of death in Rwanda, a total of 3,735 deaths were reported in 2016 from all health facilities and the ninth cause of morbidity in health centers [10]. The last Demographic and Health Survey (DHS) 2014/2015 reported neonatal mortality at 20 per 1000 live birth [11], the major cause of neonatal death is known to be a complication from PTB followed by intra and post-partum complication including birth asphyxia and infections. 90% of these deaths happen in the first 7 days of life [8]. Preterm birth is inferable to several risk factors including among others sociodemographic, environmental, obstetrical, fetal-neonatal, and newborn care. In the recently published systematic review by Laelago et al. [12] found lower age at childbirth, birth intervals, parity antenatal care (ANC) visit, gynecological infection and obstetrical complication to be associated with PTB in East Africa. Furthermore, survival or death of preterm babies is predicted by these factors along with fetal-neonatal factors and they have been reported by numerous researchers. Among them include practicing Kangaroo Mother Care, Mother serology status, and newborn breast breastfeeding [13]; sex of the new born, GA, place of delivery, presence of jaundice, and glycemic status anticipate the survival of preterm neonates [14]. The mortality due to preterm birth in Rwanda is still contributing a lot to neonatal mortality in general. it was reported the 2nd leading cause of death in 2019 in Rwanda [18]. Preterm and its complication compose the most portion of neonatal mortality whereby it is estimated that thirty five thousand of preterm babies are born every year, and 2,600 children die in Rwanda [8]. Therefore, this study aimed at determining the predictors of survival among the preterm newborn babies admitted at the University Teaching hospital of Butare (CHUB) neonatology unit from July 2019 to June 2020.

## METHODS

**Study Design:** This study was a quantitative cross-sectional conducted from July 2019 to June 2020.

**Study Site and Participants:** The study was conducted in the neonatology unit of the University Teaching Hospital of Butare (CHUB) on preterm newborns born alive and admitted between July

2019 and June 2020 [ total of 384 preterm newborns (GA<37 weeks) fulfilling inclusion criteria].

**Data Collection**: Data were extracted from the newborn personal medical file using a validated data collection sheet developed referencing to other similar published studies to ensure that it captured the maximum possible of the data elements to compute predictors of preterm birth survival [13–17]. The sheet was pilot-tested on 40 twenty-eight days old preterm birth newborns at Muhima Hospital to ensure consistency with the outcome of interest in this study. The finding from this pre-test were considered for the readjustments. The sheet has been used by the principal investigator and has recurrently checked the concordance of data entered in the sheet against the information recorded in the patient's file by another data collector (medical student) before moving to the next participant and a Cronbach alpha has been calculated at 0.74 (considered as acceptable).

**Data Analysis**: Descriptive statistics was performed, and data were presented in frequency and percentages. For assessing the predictors of preterm birth survival (defined as being discharged alive), regression analyses were conducted to identify assocaitions between socio-demographic characteristics, gynecologic and obstetric related data, preterm birth infant characteristics and the dependent variables. We calculated Hazard Ratios (HR) and their 95% confidence intervals (CI) to determine the associations between predictors and the newborn's mortality (death in hospital). Odds ratios (OR) and CI were calculated to determine survival predictors. Increased odds of death were interpreted as decreased odds of survival and vice versa. P-value was set at <0.05 for statistical significance

**Ethical Considerations**: The researcher got permission from Mount Kenya University authorities, from CHUB, as well as from Muhima Hospital ethical committee. Confidentiality, as well as anonymity, was insured during data collection and reporting of the results.

## RESULTS

Among 384 study participants, mean age of mothers was 34.86 ± 2.33) and mean gestational age at birth was age 32.94 ± 5.69 weeks. The majority of participants (52.9%) were male (Table 1). Among all neonates 96% have survived until the end of hospital stay and 4% died during hospital stay. In this study, the aim was to determine the survival of preterm newborns and 96% of preterm newborns survived till time of discharge from the neonatology department (Figure 1).

**Table 1:** *Demographic description of newborns*

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 203 | 52.9 |
| Female | 181 | 47.1 |
| Total | 384 | 100 |

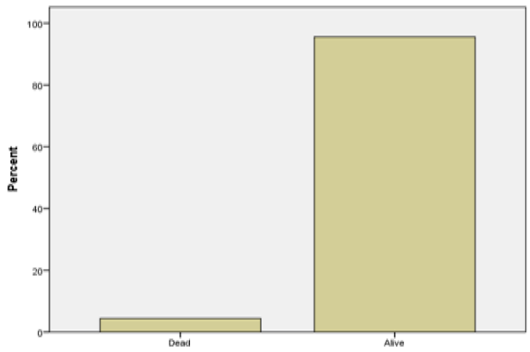


**Figure 1:** *Survival rate of preterm neonates*

**Table 2***: Survival rate of preterm neonates*

| Variables | | Surviving newborns | Survival rate |
|---|---|---|---|
| Maternal age (in years) | | | |
| <25 | 29 (7.6%) | 27 | 7.0% |
| 25-29 | 63 (16.4%) | 59 | 15.4% |
| 30-34 | 143 (37.2) | 138 | 35.9% |
| 35-39 | 97 (25.3%) | 94 | 24.5% |
| ≥40 | 52 (13.5%) | 51 | 13.3% |
| Antenatal care (ANC) visits | | | |
| <4 ANC | 161 (41.9) | 150 | 39.1% |
| ≥4 ANC | 223 (58.1%) | 219 | 57.0% |
| Parity | | | |
| Primiparous | 104 (27.1%) | 92 | 24% |
| 2-4 | 225 (64.4%) | 248 | 64.8% |
| ≥5 | 25 (6.5%) | 28 | 7.30% |

A high survival rate was among newborns with mothers of 30-34 years age group (survival rate of 35.9%), newborns with mothers having attended at least four antenatal visits (survival rate of 57.0%)

and newborns with multiparous mothers (survival rate of 34.8%) (Table 2).

There was a significant difference between the survival of newborns who cried immediately after birth and those who did not (p<0.001), with a higher survival among those who cried immediately after birth. The survival of newborns who did not cry immediately after birth tended to decrease with time (Figure 2).

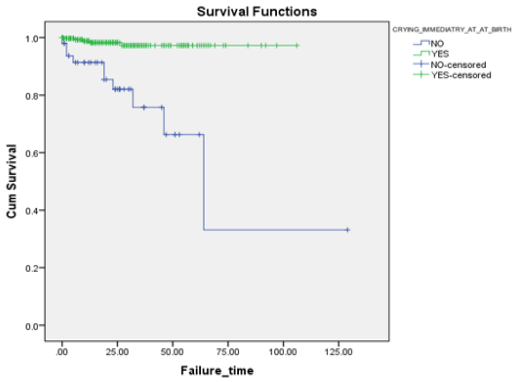


**Figure 2:** *Kaplan Meier curve (by crying immediately after birth) of surviving preterm newborns (Log Rank (Mantel -Cox): chi _Square: 28.114 and p<0. 001)*

There is a significant difference in the survival rates of newborns depending on the GA (p<0. 001), with GA of 34 weeks and above being associated with the highest survival, followed by GA of 32-33.9 weeks (Figure 3). Among newborn characteristics, the number of ANC visits significantly associated with time to event (death) (aHR: 0.22, 95% CI: 0.06-0.78, P=0.02) (Table 3). Among maternal gynecologic and obstetric factors, crying immediately after birth significantly associated with time to death (aHR: 0.09, 95% CI: 0.02-0.37, P<0.001) (Table 4). Number of antenatal care (ANC) visits and parity were associated

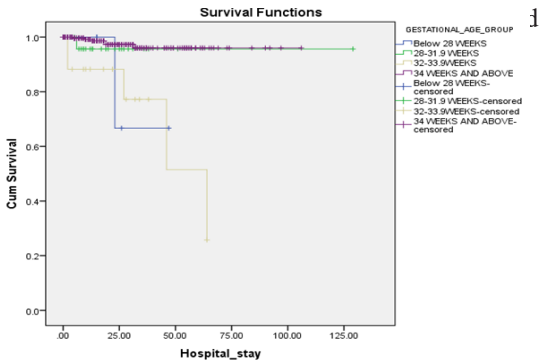


**Figure 2:** *Kaplan Meier curve (gestational age at birth) of surviving preterm newborns (Log Rank (Mantel -Cox): chi _Square:27.460 and p value<0.001)*

However, they were not significantly associated with survival on multiple logistic regression analysis.

Gestational age and crying of the baby have been found to be significantly associated with survival of preterm newborns (p=0.004 and p=0.001, respectively) in multivariate analysis (Table 6).

## DISCUSSION

Preterm newborns face increased risks of mortality and morbidity due to their physiological immaturity. Identifying predictors of survival among preterm infants is crucial for optimizing neonatal care and improving outcomes. This study explored the predictors of survival among preterm newborns at the CHUB, and found that the survival of preterm newborns till time of discharge from the neonatology department was 96%. This survival rate is higher than the one found in Ethiopia (72.9%) [18,19], and the one previously reported in Rwinkwavu and Kirehe district hospitals (86.7%) [20].

**Table 3***: Cox Regression table for Preterm newborn characteristics as predictors of time to event (death) of preterm newborns*

| Preterm newborn characteristics | p-value | CHR | 95% CI | | p-value | aHR | 95.0% CI | |
|---|---|---|---|---|---|---|---|---|
| | | | Lower | Upper | | | Lower | Upper |
| Age of mother at childbirth | 0.221 | 0.728 | 4.38 | 1.21 | 0.577 | 0.851 | 0.482 | 1.503 |
| Number of ANC visits | 0.024 | 0.225 | 0.62 | 0.818 | 0.02 | 0.215 | 0.059 | 0.783 |
| Parity | 0.091 | 0.418 | 0.152 | 1.15 | 0.25 | 0.489 | 0.145 | 1.655 |

*Statically significant; CHR: Crude Hazard ratio; aHR: Adjusted Hazard ratio; CI: Confidence Interval; ANC: antenatal care*

**Table 4:** *Cox Regression table for newnatal predictors of time to event (death)of preterm newborns*

| Newnatal factors | p-value | CHR | 95% CI | | p value | aHR | 95.0% CI | |
|---|---|---|---|---|---|---|---|---|
| | | | Lower | Upper | | | Lower | Upper |
| Sex | 0.275 | 0.536 | 0.165 | 1.642 | 0.299 | 0.54 | 0.169 | 1.727 |
| Gestational age group | 0.08 | 0.501 | 0.299 | 0.3 | 0.907 | 0.957 | 0.46 | 1.991 |
| Birth weight group | 0.194 | 0.525 | 0.198 | 1.388 | 0.839 | 0.871 | 0.23 | 3.298 |
| Apgar_at_birth | 0.035 | 0.28 | 0.086 | 0.915 | 0.465 | 0.613 | 0.165 | 2.278 |
| pernatal_asphyxia_ diagnosed_at_birth | 0.427 | 2.294 | 0.296 | 17.798 | 0.815 | 1.351 | 0.109 | 16.731 |
| Hypoglycemia diagn0sed at admission | 0.988 | 1.016 | 0.132 | 7.827 | 0.475 | 0.402 | 0.033 | 4.903 |
| Jaundice | 0.64 | 1.636 | 0.208 | 12.867 | 0.912 | 1.146 | 0.102 | 12.837 |
| Neonate received CPAP | 0.224 | 2.257 | 0.608 | 8.369 | 0.952 | 1.048 | 0.233 | 4.716 |
| Crying immediately after birth | <0.001 | 0.82 | 0.025 | 0.268 | | 0.093 | 0.024 | 0.356 |
| Single liveborn infant delivered by cesarean delivery | 0.327 | 1.194 | 0.196 | 16.198 | 0.115 | 0.151 | 0.009 | 15.631 |
| Single liveborn infant born outside hospital | 0.53 | 1.536 | 0.108 | 10.767 | 0.812 | 1.046 | 0.002 | 11.737 |
| Suspected musculoskaletal condition | 0.24 | 1.257 | 0.508 | 7.369 | 0.852 | 1.048 | 0.133 | 3.16 |

Crying immediately after birth was associated with a higher survival and longer time to death ($p<0.001$), and a higher gestational age was associated with a higher survival rate ($p=0.004$). These findings are similar to the ones found in studies conducted in similar settings at University Teaching Hospital of Kigali and Muhima hospital [21], as well as in Ethiopia, both at Mizan Tepi University Teaching Hospital [14] and at Gondar comprehensive specialized hospital neonatal intensive care unit, Northwest Ethiopia [22]. Crying immediately after birth is an important indicator of newborn vitality and respiratory function [23]. It helps clear fluid from the lungs and facilitates the expansion of alveoli, thus reducing the risk of respiratory distress [24]. Consequently, preterm infants who cry immediately after birth are more likely to have better outcomes and a higher likelihood of survival, while those who do not are more likely to have poor outcomes [25]. Prematurity severity increases with decreasing gestational age, and research shows that extremely preterm infants, born before 28 weeks of gestation, face significant challenges due to underdeveloped organ systems and are at a higher risk of mortality. Moreover, moderately preterm infants, born between 32 and 37 weeks of gestation, have a better prognosis and higher survival rates [26,27]. Research showed that gestational age is associated with birthweight, which is another survival predictor in prematurity. Though it was not significantly associated with survival in our study, similar studies in Rwanda and other African countries showed that low birthweight was associated with high mortality [28–30]. Another study in Uganda showed that extreme preterm newborns had higher mortality rate than late preterm newborns [31]. Adequate prenatal care allows for early identification and management of risk factors associated with preterm birth, and provides an opportunity to monitor maternal conditions, identify signs of preterm labor, administer appropriate interventions, and offer education regarding preterm birth prevention [32] Mothers who receive timely and comprehensive antenatal care are more likely to have healthier pregnancies, reducing the risk of preterm birth and improving the survival chances of their newborns [32,33]. Aligning with other studies conducted in Rwanda, Ethiopia and Uganda [14,22,31, 33], our findings showed that the number antenatal

**Table 5:** *Maternal gynecologic and obstetric predictors of survival and survival in preterm newborns*

| Variables | | COR | [95% CI] | p-value | aOR | [95% CI] | p-value |
|---|---|---|---|---|---|---|---|
| Maternal age group (in years) | | | | 0.676 | | | 0.799 |
| <25 | 29 (7.6%) | ref | - | | ref | - | |
| 25-29 | 63 (16.4%) | | [0.16, 5.31] | | 2.92 | [0.20, 42.69] | |
| 30-34 | 143 (37.2) | | [0.09, 2.65] | | 3.65 | [0.23, 59.04] | |
| 35-39 | 97 (25.3%) | | [0.07, 2.71] | | 1.55 | [0.07, 35.71] | |
| ≥40 | 52 (13.5%) | 0.26 | [0.02, 3.05] | | 1.15 | [0.03, 45.79] | |
| Number of antenatal care (ANC) visits | | | | 0.019 | | | 0.371 |
| <4 ANC | 161 (41.9) | ref | - | | ref | - | |
| ≥4ANC 223 (58.1%) | | 0.25 | [0.08, 0.80] | | 0.50 | [0.11, 2.26] | |
| Parity | | | | 0.024 | | | 0.297 |
| Primiparous 104 (27.1%) | | ref | - | | ref | - | |
| 2-4 | 225 (64.4%) | 0.21 | [0.07, 0.65] | | 0.29 | [0.06, 1.55] | |
| ≥5 | 25 (6.5%) | 0.44 | [0.05, 3.64] | | 0.80 | [0.04, 14.54] | |

care visits was associated with the time to death among preterm newborns, with a higher number being associated with longer time to death (aHR: 0.22, p=0.02). However, cumulatively, there was no significant association with the survival rate on multiple logistic regression. In contrast, research has indicated that women with no ANC visits were 3 times more likely to have low birthweight babies and their babies were 5 times likely to dies than babies of mothers with regular ANC visits [34].

The survival of preterm newborns till time of discharge from the neonatology department was 96%. This survival rate is higher than the one found in Ethiopia as well as in Cameroun (most likely) due to that fact that this study population was with less vulnerable (was with lesser fatal diseases and conditions) [17]. Gestational age and crying of the baby have been found to be significantly associated with survival of preterm newborns at p values of 0.004 and 0.001 respectively. This is due to the fact that, with increasing gestational age, morbidity and morbidity of newbons decreases and this increases survival [19]. These findings are similar to the ones found in studies conducted in similar settings in Ethiopia, both at Mizan Tepi University Teaching Hospital [20] and at Gondar comprehensive specialized hospital neonatal intensive care unit, Northwest Ethiopia [17]. Being late preterm newborn is associated with survival, this is in line with similar studies in similar settings in Ghana where babies born with high birth weight survive longer than those with lower birthweight [21,22][23]. This is similar to findings in Uganda where extreme preterm newborns have higher mortality than late preterm newborns [24].

This study has some limitations, including lack of control of confounding factors, such as health system and hospital specific factors, associated with survival of preterm newborns. Due to the design of this study, advanced factors (genetic or biomarkers factors) were not considered in the

**Table 6:** *Newnatal predictors of survival in preterm neonates*

| Variables | N (%) | COR | [95% CI] | p-value | aOR | [95% CI] | p-value |
|---|---|---|---|---|---|---|---|
| Preterm newborn characteristics | | | | | | | |
| Sex | | | | 0.314 | | | 0.763 |
| Female | 181 (47.1%) | ref | - | | ref | - | |
| Male | 203 (52.9%) | 0.58 | [0.20, 1.67] | | | [1.97-12.38] | |
| Gestational age (in weeks) | | | | <0.001 | | | 0.004 |
| <29 | 6 (1.6%) | ref | - | | ref | - | |
| 29-31 | 32 (8.3%) | 6 | [1.2,23] | | 0.523 | [0.89,123,8] | |
| 32-33 | 20 (5.2%) | 5.00 | [1.10, 22.82] | | 0.327 | [0.54,61.2] | |
| ≥34 | 326 (84.9) | 0.22 | [0.05, 0.91] | | 0.017 | [1.8, 425.1] | |
| Birth weight (in grams) | | | | 0.225 | | | 0.608 |
| <1,000 | 4 (1%) | ref | - | | ref | - | |
| 1000-1,499 | 56 (14.6%) | 0.48 | [0.15, 1.57] | | 1.66 | [0.24, 11.44] | |
| >/=1,500 | 324 (84.4%) | 0.333 | [0.1,2.0] | | 1.44 | [0.3-8] | |
| Crying at birth | 333 (86.7%) | | | <0.001 | | | 0.001 |
| No | 51 (13.3%) | ref | - | | ref | - | |
| Yes | 333 (86.7%) | 0.06 | [0.02, 0.19] | | 0.08 | [0.02, 0.37] | |
| APGAR at birth | | | | 0.015 | | | 0.214 |
| Low APGAR | 156(40.6) | ref | - | | ref | - | |
| Good APGAR | 228 (59.4) | 0.24 | [0.07, 0.75] | | 0.40 | [0.10, 1.69] | |
| Hypoglycemia diagnosed at admission | | | | 0.895 | | | 0.528 |
| No | 30 (7.8%) | ref | - | | ref | - | |
| Yes | 354 (92.8%) | 0.87 | [0.11, 6.86] | | 0.41 | [0.03, 6.42] | |
| Diagnosed with Jaundice | | | | 0.955 | | | 0.655 |
| No | 27 (7%) | ref | - | | ref | - | |
| Yes | 357 (93%) | 0.94 | [0.12, 7.45] | | 0.54 | [0.03, 8.27] | |
| Diagnosed with perinatal asphyxia at birth | | | | 0.127 | | | 0.653 |
| No | 366 (95.3) | ref | - | | ref | - | |
| Yes | 18 (4.7) | 3.39 | [0.71, 16.33] | | 1.85 | [0.13, 26.99] | |
| CPAP received | | | | 0.317 | | | 0.957 |
| No | 339 (88.3%) | ref | - | | ref | - | |
| Yes | 45 (11.7%) | 1.95 | [0.53, 7.18] | | 0.95 | [0.15, 5.99] | |
| Z38.01 Single liveborn_ infant_delivered by cesarean | | | | 0.13 | | | 0.66 |

*P<0.05: Statically significant; COR: Crude Odds Ratio; aOR: Adjugated Odds Ratio; CI: Confidence Interval; CPAP: Continuous Positive Airway Pressure; APGAR: Appearance, Pulse, Grimace, Activity, and Respiration*

assessment of survival predictors.

## CONCLUSION

This study showed a high survival rate among preterm newborns studied and survival and time to death predictors, including crying immediately after birth, gestational and antenatal visits. Understanding these predictors enhances clinical decision-making and facilitates targeted interventions to improve the survival rates and long-term outcomes of preterm infants. Therefore, we urge the leadership of CHUB and the ministry of health to establish and improve measures in place to target these identified factors to increase further the survival rate of preterm newborns. Neonatology staff should do their best to provide standard care focusing newborns with identified risk factors. Further studies should be conducted and extend to healthcare facilities that transfer to CHUB to provide information on preterm newborns' care.

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