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Determinants of Neonatal Mortality in Referral Facilities of the Health Districts in North Kivu, Democratic Republic of Congo

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Abstract

Over the last two decades, several countries that implemented strategies for reaching the Millennium Development Goals (MDGs), have reduced their infant mortality by more than half. In spite of global decrease in infant mortality, in 2015, on the point of completion of the MDGs, Sub-Saharan Africa countries among them Democratic Republic of Congo (DRC), remained with highest infant mortality rate. Although making progress, neonatal mortality rate is declining less rapidly than the under-five mortality rate. In order to accelerate reaching infant mortality rate target, several countries among them DRC, have implemented strategies to substantially reduce neonatal mortality.

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In order to target actions, a descriptive cross-sectional study of neonatal deaths occurred between January 1st, 2009 and June 30th, 2014 was performed in referral health facilities of 6 North Kivu province health zones in DRC. Acute fetal distress, premature birth and infection were found to be the causes of 83.4% (n = 235) of newborn deaths. Inadequate staff capacities and / or poor management were implicated in the occurrence of 52.9% (n = 225) deaths, linked to a set made of acute fetal distress, premature birth and infection including sepsis and pneumonia. Results show that implementation of sophisticated structures such as neonatal intensive care units are not necessary to reduce neonatal mortality in the context of health facilities in DRC. A rational organization of care management including staff training, application of effective interventions and targeted low cost strategies to fight effectively against neonatal mortality would contribute significantly to reduce infant mortality.

Keywords: Neonatal; Rwenzori; ULB-coopération; infant mortality; DRC; North Kivu.

1. Introduction

Death exists ... men and women know this, but the loss of a child is an unspeakable pain for parents [1] and a misunderstanding in African society!

An estimated 5.9 million children under 5 years, 16,000 children daily, 11 children every minute died in 2015 throughout the world [2], most due to avoidable diseases [3]. With one child in 12 dying before his fifth birthday, the under-five mortality rate was highest in sub-Saharan Africa [2].

Faced with this evidence, most countries have subscribed to the Millennium Development Goals (MDGs). The reduction of two thirds of infant mortality rate by the end of 2015 was the target of the fourth Millennium Development Goal (MDG 4).

Over the past two decades, several countries that implemented strategies for reaching the MDGs, have reduced their infant mortality rates by more than half.

Between 1990 and 2015, substantial progress in the reduction of infant mortality was realized globally. In spite of the population growth in developing countries, the number of deaths of children under-five has decreased, from 12.7 million in 1990 to 5.9 million in 2015 [3].

In spite of this substantial decrease in infant mortality, in 2015, on the point of completion of the MDGs, Sub-Saharan Africa remains with the highest infant mortality rate [3]. In 2015, sub-Saharan Africa represented half the burden of under five deaths, with about 3 million deaths [3].

Among African countries, twelve including the Democratic Republic of Congo (DRC) had until the end of 2015, the highest rate of infant mortality [4].

Although making progress the neonatal mortality rate is declining less rapidly than the under-five mortality rate. [3].

Newborn deaths still accounted for over 45% of all deaths of children under five in 2015 [4].

There is even some evidence that the majority of neonatal deaths (75%) occur during the first week of life, and among these, between 25 to 45% occur in the first 24 hours [1]. In 2015, for approximately 1 million children, their first day of life was also their last [4]. Almost 99% of newborn deaths occur in low-income countries [3] among them DRC.

Neonatal mortality is a subset of infant mortality. It is one of the indicators of the quality of obstetric and neonatal care. Neonatal mortality depends partly on the socio-economic development level of a country. It is one of the indicators of the level of investment in maternal child healthcare.

This situation shows that neonatal mortality remains a public health problem in many countries; three-quarters of neonatal deaths worldwide are attributable to three causes: prematurity, birth-related complications (birth asphyxia) and neonatal sepsis [5,6,7,8].

In order to accelerate reaching the infant mortality rate target, several countries among them DRC, have implemented strategies to substantially reduce neonatal mortality.

In order to target actions, an understanding of the causal factors of neonatal mortality is required in the context of the deaths occurring.

The main objective of this study was to identify factors contributing to neonatal mortality in referral health facilities of 6 North Kivu province health zones supported by the PAPNDS (“Projet d’Appui au Plan de National de Développement Sanitaire”).

2. Materials and methods

The study took place in North Kivu province in eastern DRC. A descriptive cross-sectional study of neonatal deaths occurred between January 1st, 2009 and June 30th, 2014 was performed.

The study was conducted in health zones: Biena (HGR Mambowa, Biambwe CSR, CSR Mwenye, CSR Kambau), Kyondo (HGR Kyondo, Kyavinyonge CSR, CSR Kyalumba, CMC Bwalyana, Burusi CSR), Manguredjipa (HGR Mangurejipa, CSR Kambau), Masereka (HGR Maserreka, CSR Muhati, Kitsimba CSR, CSR Magherya), Musienene (HGR Musienene, Mukongo CH, CH Vusamba, CH Vughalihya, CH Tumaini and Buyinga CSR) and Vuhovi (HGR Vuhovi, CSR Bulambo and Vumba CMC) reference health facilities in the North Kivu province.

Six investigators were recruited from amongst the clinical staff in relevant health zones and Butembo Health District. None of the investigators were involved in the study within their own health zones. A pilot study was performed at the General Hospital Kitatumba in Butembo health zone.

Data were collected for both cases of deaths: the first four weeks of newborn life and the delivery having

allowed the birth of the dead newborn child. All of the available medical files of deceased newborns and / or their mothers were included in the analysis. Mortality audits where available, were used to complete information.

Data were coded on a standardised data collection sheet.

The data collected included the clinical aspects of neonatal mortality as well as information on the general management of the deceased newborns.

Neonatal death was defined as death occurring between 0 and 28 days of life. Early neonatal mortality was understood as a death occurring between 0 and 7 days of life.

Late neonatal mortality was defined as any death occurring between 8 and 28 days of life.

Additional information on the live births and the completeness of the registration of neonatal deaths during the period covered by the study was requested to the health facilities of the six health zones supported by the PAPNDS project.

Microsoft Excel 2013 and SPSS version 20 were used for data processing.

3. Results

3.1 Care management issues of deceased newborns

Between January 1st, 2009 and June 30th, 2014, 945 newborns died out of 77,671 live births registered within the 23 referral health centres of the six health zones.

The neonatal mortality rate was 12 deaths per 1000 live births. These neonatal deaths represented 57.9% of the total under-five deaths recorded.

Only 251 medical files of mother and / or newborn out of 945 newborn deaths recorded in 23 health facilities during the study period were made available, 26.6% of the total.

Elements from these 251 records were used for further analysis.

Figures 1 and 2 summarize the completeness of the respective records of the mother and the newborn who died in the referral health centres in six health zones. About a third of the medical files could not be retrieved for both the deceased newborn and the mother.

It was shown that 48.4% (n = 244) of the deceased newborns were born at the General Hospital, 35.2% at the secondary level hospitals or referral health centers, and 13.1% at the health centers. Births that occurred in private health facilities and outside of the health zones accounted for 2.5% and 0.8% (n = 244) respectively of the total.

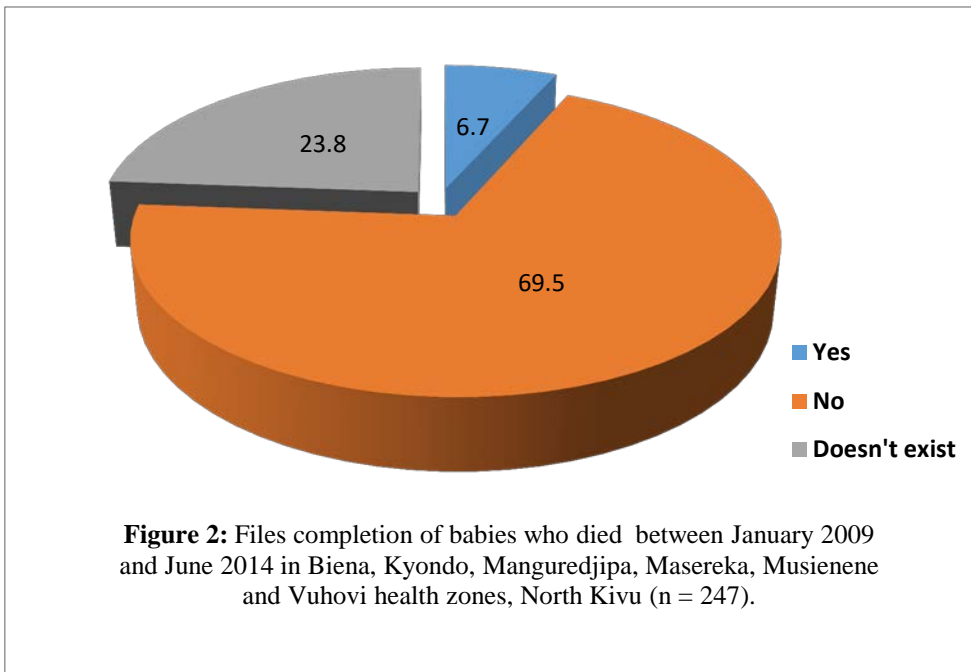
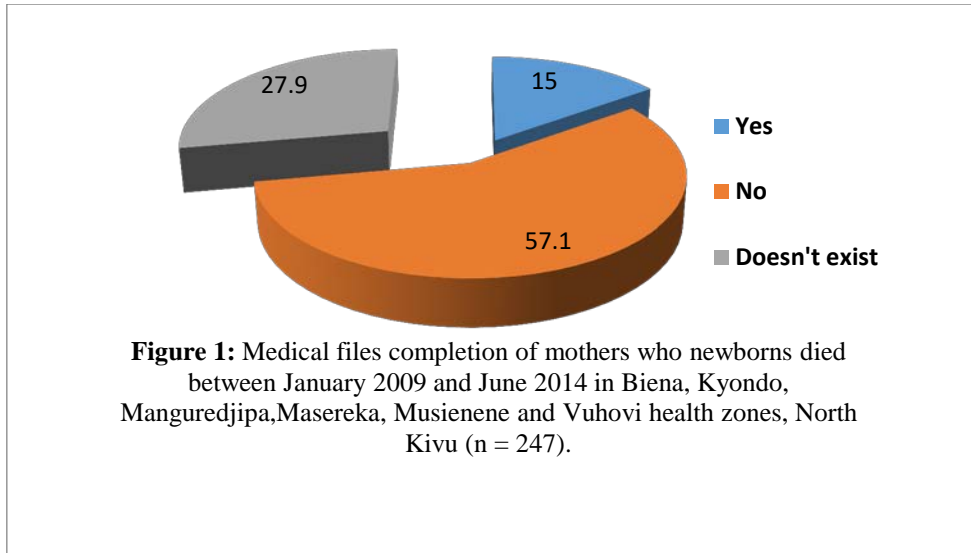


Table 1 shows the completeness of the contents of the deceased newborn files analyzed by health zone. Among the six health zones included, only one, Kyondo, had close to 20% of the clinical files completed for the newborn and 60% of the maternal files (not shown). Other health zones did not present as good a performance for the completeness of the records of mothers who gave birth at the General Hospital or at the referral health center whose newborns died.

In this zone of health of Kyondo, only a small proportion [1.8 % (n=57)] of files (cases) of the mothers of newborn deaths included in analyses have not been found (not shown).

Table 1 : Content completion of deceased newborns files between January 2009 and June 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi health zone(hz)s, North Kivu (n = 239)

	Yes (%)	No (%)	Doesn't exist (%)
Biena (n=33)	0,0	100,0	0,0
Kyondo (n=57)	19,3	66,7	14,0
Mangurejipa (n=18)	0,0	94,4	5,6
Masereka (n=29)	0,0	79,3	20,7
Musienene (n=57)	5,3	42,1	52,6
Vuhovi (n=42)	4,8	66,7	28,6

For the deceased newborns, none of the health zone had more than 1/5 of medical files completed. Over 90% of medical files were available in Biena and Mangurejipa health zones with 16% (n = 239) full completed.

It was noted that physicians and nurses or midwives were responsible for 90.6% (n = 138) of the incompleteness of mother's files. Physicians were solely responsible for 5.1% (n = 138).

Concerning the newborn records, the common responsibility of physicians and nurses or midwives was observed in 85.5% (n = 165) of cases. The physician responsibility was noted in 9.1% of cases.

On an annual basis, the monthly distribution of deaths monthly was equal (not shown). Although a peak was noted in March, there was no significant difference with other months.

3.2 Basic characteristics of deceased newborns

The gender distribution of the study population (newborns deceased between January 1st, 2009 and June 30th, 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi referral health centres) was homogeneous. An excess male mortality trend was noted. Girls accounted for 43.5% (n = 246) of deaths. The majority of deliveries were vaginal (spontaneous vaginal birth and normal delivery with episiotomy) which represented 63.7% (n = 212) and 34.4% were delivered by caesarean section.

The most common place of birth was the referral health centres. The proportion of newborns who died in these facilities was 83.6% (n = 244).

Health centers and private facilities recorded 13.1% and 2.5% respectively of neonatal deaths. Only 0.8% (n=244) of deaths occurred in facilities located out of the study areas (Health zones included in the study).

Among deceased newborns, 42.4% (n = 205) had cried at birth.

Deceased neonates were delivered by relatively young mothers [median age (minimum – maximum) 25 years (15 – 48)] and without specific obstetrical antecedent [median gravidity (minimum – maximum) 2 (1 – 14)]. The

median rank of the dead baby (minimum - maximum) at his mother was 2 (1 – 13).

Otherwise, the newborns' anthropometric parameters were as follows: mean (SD) weight, height and head circumference were respectively [2388 g (664.9) (n = 230)], [44.98 cm (4.32) (n = 43)] and [33.3 cm (5.18) (n = 41)] at birth.

Most of the newborn deaths occurred within the first 24 hours of birth. The proportion of deaths at 24 hours or less, was 83.5% (n = 243), 9.5% (n = 243) for 3 to 7 days of life and 7 % (n = 243) for more than 7 days infants.

There was a higher mortality amongst newborn males primarily for the first 7 days of life [57,9% (n = 221)] and among females beyond seven days [70,6% (n = 17)] ; however the difference was not statically significant (p = 0.071).

Among 252 newborns who died, the gestational age was recorded for 157 babies including 44 premature infants and 3 post mature infants.

The proportion of newborns born at term that died was slightly higher amongst males compared to females but the difference was not statistically significant.

Most newborns who died were eutrophic [52.8% (n = 229)] at birth; the hypotrophic and macrosomic represented 46.7% and 0.4%, respectively (n = 229). The proportion of low birth weight newborns (birth weight <2500 g) was 48.7% (n = 230). Among these low birth weight infants, 77.7% (n = 112), had a weight between 1500 and 2499 grams.

A higher proportion of eutrophic infants were observed amongst males [58.6% (n = 128)] than females [45.5% (n = 99)], while low birth weight was more common in females [54.5% (n = 99)] compared to males [40.6% (n = 128)] (p = 0.044).

The majority of low birth weight newborns were premature [91.1% (n = 44)]. Amongst the infants born at term, 26.4% (n = 106) were low birth weight.

3.3 Causes of neonatal deaths

It was observed that 81.8% (n = 247) of neonatal deaths recorded were due to five causes: asphyxia (39.3%), hypothermia (21.1%), hypoglycaemia (12.1%), hyperthermia and dehydration (9.3%).

Indirect causes were responsible for 83.4% (n = 235) of newborn deaths. These indirect causes included acute fetal distress (34.9%), premature birth (29.8%) and infection (18.7%).

Table 2 represents the factors contributing to the newborn deaths in the 23 referral health centres of the six health zones included in the study. Together the combination of «insufficient staff capacity" and "poor management" contributed to around 60% of newborn deaths.

Table 2 : Most important factors contributing to newborns death between January 2009 and June 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi, health zones ,North Kivu

Factor	% (n = 240)
Health facility staff capacities insufficient	43.8
Poor quality of clinical care	15.8
Lack in care facilities	14.2
Any factor	12.5
Untimely consultation	6.3
Others factors	6.3
Lack of specific drug	0.8
Poorly organization services	0.4

Delays in seeking care by the community represented 6.3% (n = 240) of cases. Table 3 shows the direct cause of death based on staff capacities and / or the management of cases compared to other factors. Inadequate staff capacities and / or poor management favoured the occurrence of 134 deaths directly, which represents 56.8% (n = 236), linked to a set made up of asphyxia, hypoglycemia, hyperthermia and deshydration.

Table 3: Direct causes of newborns death based on health facility staff capacities and / or the quality of clinical care between January 2009 and June 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi, health zones, North Kivu.

	Health facility staff capacities insufficient and / or the poor quality of clinical care % (n = 142)	Others contributing factors % (n = 94)
Asphyxia	40,1	39,4
Hypothermia	25,4	14,9
Hypoglycemia	11,3	13,8
Hyperthermia + Dehydration	11,3	6,40
Others causes of death	4,9	17,0
Hyperthermia	4,2	6,4
Deshydration	2,1	0,0
Ionic and gaseous disorders	0,7	2,1

The indirect causes are presented in table 4. Inadequate staff capacities and / or poor management were implicated in the occurrence of 122 deaths, which represents 52.9% (n = 225) linked to a set made of acute fetal distress, premature birth and infection including sepsis and pneumonia.

Table 4: Indirect causes of newborns death based on health facility staff capacities and / or the quality of clinical care between January 2009 and June 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi, health zones, North Kivu.

Cause of death	Health facility staff capacities insufficient and / or the poor quality of clinical care % (n = 136)	Others contributing factors % (n = 89)
Acute fetal suffering	39,7	29,2
Prematurity	26,5	34,8
Septicemia	9,6	9,0
Pneumonia	9,6	5,6
Meningitis	2,2	3,4
jaundice	1,5	1,1
Hemorrhagic disease	1,5	0,0
Tetanus	0,7	0,0
Congenital malformation	Heart 0,0	2,2
Others indirect causes	5,9	11,2
Others malformation	2,9	3,4

Table 5 presents early mortality depending on the spontaneous crying at birth, staff capabilities and gestational age of the newborn. The absence of spontaneous crying at birth and the insufficient capacity of the support staff contributed to newborn mortality within 24 hours. Among the causes of early neonatal mortality, acute fetal distress, prematurity and infections were responsible respectively for 40.0%, 30.3% and 16.8% (n = 185) of neonatal deaths.

Table 5: Early neonatal death between January 2009 and June 2014 in Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi, health zones, North Kivu depending on certain factors.

Parameters	% early neonatal death	p
Insufficient staff capacity		
Yes (n=136)	88,2%	0.035
No (n=95)	77,9%	
Spontaneous crying at birth		
Yes (n = 84)	71,4%	< 0.001
No (n = 111)	94,6%	
Gestationnal age		
Prematurity or dysmaturity (n = 42)	83,3%	0.37
At term (n = 107)	88,8%	

The review of the maternal files of those newborns who died showed: body temperature was not filled in for 48.3% (n=178) in the partographs when the labour started. Amniotic fluid details were filled in 70.8% (n=178) of cases. The fetal position was specified for 89.3% (n = 178) of women during labour. The mother's weight

was specified for 93.3% (n = 178) and 93.8% (n = 178) recorded parity and gravidity.

Concerning the newborn with complete files available, the temperature was filled in on admission to the "neonatal unit" only from 81.8% (n = 182) of them. When taken, 99.3% of the temperature results was axillary. Cardiac and respiratory rates were both filled in 36.8% (n = 182) of cases. For newborns who died, 53 died from an immediate or acute respiratory fetal distress. The respiratory rate was not filled in for 24.5% of cases.

Finally, the weight had been specified for 89.0% (n = 182) of the babies who died. Height and head circumference were filled in 19.8% (n = 182) of cases.

4. Discussion

The study analysed 251 cases of deceased newborns which represents 26.6% of all newborn deaths recorded in 23 health referral facilities of 6 health zones: Biena, Kyondo, Mangurejipa, Masereka, Musienene and Vuhovi, supported by the PA PNDS in the province of North Kivu in eastern DRC between January 1st, 2009 and June 30th, 2014.

Neonatal mortality in these referral health facilities was 12 per 1,000 live births for the period of the study. Prematurity was present in 83.5% of the cases. The proportion of neonatal deaths was 57.9% amongst the total deaths of children under-five years.

Acute fetal distress, premature birth and infection were the most important causes of death. The major contributing factors were "the lack of capacity of staff" and "insufficient care management". These two factors contributed to more than 50% of deaths related to acute fetal distress, prematurity and infection.

The level of neonatal mortality observed classified these health areas in the category of low neonatal mortality (<15 deaths per 1,000 live births). This level was low compared to the average of the Democratic Republic of Congo that was 30 per 1000 live births during the study period. This observation is consistent with that made in the DRC EDS-II report. Indeed, the lowest child of 0-1 years mortality rate was noted in North Kivu province [10].

However, compared to the under-five children's deaths, neonatal mortality observed in our study was higher than the rate observed elsewhere. Estimates made in 2013 show that newborn deaths account for 44% of all under-five children's deaths [11].

While recent estimates show that the level of early neonatal mortality varies from one context to another [12], the rate observed in 23 referral health centres of the six health zones of the study was high.

The main causes of neonatal mortality observed in our study are similar to those reported elsewhere [5]. Generally, three quarters of neonatal deaths worldwide are attributable to three causes: prematurity (29%), asphyxia (23%) and serious infections including sepsis and pneumonia (25%). However, the distribution of these causes is variable according to the region's level of development. Severe infection represents 40-45% of

total neonatal deaths in countries with high neonatal mortality ($> 45/1000$ / year) while it represents 15% in countries with low neonatal mortality ($<15/1000$ / year). The study shows that three causes are responsible for more than 80% of deaths, but it was noted also that acute fetal distress is the first disease entity. The quality of obstetric care would have more weight among the determinants of neonatal mortality in the study context.

The early neonatal mortality level helps to confirm this observation.

This implies that the majority of newborn deaths in the study could have been avoided through improved obstetric care during childbirth to reduce the frequency of asphyxia. In Britain, the strategy for improving obstetric care has already significantly reduced neonatal mortality between 1940 and 1975 [13].

Special staff training in the application of effective and low cost interventions, including improvement of obstetric care, would contribute to improved neonatal mortality prevention.

Indeed, low income countries such as Honduras, Nicaragua, Sri Lanka and Vietnam reached a net decrease in neonatal mortality despite limited resources [13].

Staff training is an absolute necessity in the context of the study sites since over 50% of deaths could be prevented if the staff had the capacity for effective case management.

These interventions should be tailored to each health facility. Note that the strongest impacts are less dependent on case management and the technical equipment made available compared to the organization and the health care staff competence [14,15].

The transposition of conventional strategies is not recommended. These conventional strategies are based on studies conducted in some high-income countries. Around 99% of all neonatal deaths reported worldwide occur in low income countries.

Despite this, most research in the area of neonatal health is focused on the 1% of more than five million annual deaths observed in developed countries [2]. Furthermore, this research is conducted in high-income countries and focuses primarily on improving the care of premature or very low birth weight infants [2].

In the study context, interventions should target the management of asphyxia in addition to prevention, skin-to-skin care (kangourou mother care) for premature infants and the rational use of antibiotics. These are strategies proven to result in a substantial reduction in neonatal mortality [15].

In addition to the implementation of protocols for effective interventions, a better organization of the neonatology services is an asset for better care of sick newborns. In the context of the study, the measurement of anthropometric parameters and vital signs of sick newborns has a marginal cost impact in health facilities. These parameters, neglected according to the results of our study, however, are essential for effective implementation of management protocols.

Implementation of continuous clinical training programs aimed at medical as well as nursing staff based on the observed deficiencies in care could be a very big contribution to the reduction of neonatal mortality in low income countries.

5. Conclusion

The objective of the study was to identify the factors contributing to neonatal mortality in 6 referral health centres in six health zones supported by the PA PNDS.

Acute fetal distress, premature birth and infection were found to be the main causes of newborn deaths. The major contributing factors were "the lack of capacity of staff" and "insufficient case management".

While modern societies require highly technical neonatal care, results show that implementation of sophisticated structures such as neonatal intensive care units are not necessary to reduce neonatal mortality in the context of health facilities in North Kivu Province in DRC.

The rational organization of the care management including staff training, application of effective interventions and targeted low cost strategies to fight effectively against neonatal mortality would contribute significantly to reduce the under-five mortality rate.

6. Recommendations

- A rational organization of care management should contribute to fight effectively against neonatal mortality by reducing the under-five mortality rate. That organisation should do so by taking the following measures:
- Every sick newborn should be considered as a fully-patient and hence benefit from individualized clinical examination and follow-up on the basis of medical file;
- For the effective management of a sick newborn case, staff training should target on competencies in order to diagnose and treat as soon as possible asphyxia, hypoglycaemia, hypothermia, dehydration and hyperthermia is an absolute necessity;
- The sick newborn care coordination should be reinforced by setting up adapted mechanisms and tools.
- The integration of the WHO and Unicef strategies of newborns care from the community to the health facilities level using innovative methods such as the identification of pregnancies, surveillance of "danger signs" with the newborn on birth and adequate care according to the sign developed by the newborn can be an additive for an effective management.
- The integration of the WHO and Unicef strategies of newborns care from the community to the health facilities level using innovative methods such as the identification of pregnancies and births for the surveillance of "danger signs" with the newborn and possibly adapted care according to the sign of danger that the newborn develops can be an additive for an effective management.

7. Limitations

This study has some constraints and limitations and future studies in the area are needed to supplement it:

- The Data were not designed for a study about the determinants of neonatal mortality in the region. A more appropriate protocol should be designed in order to better understand the problem.
- The absence of many deceased newborns medical files during the study period is another limitation for the correct inference of observations.
- It was not possible to collect data related to human factors so as to identify actions to be carried out in relation to behavioural change.
- PAPNDS / European Union financial support was limited to the six Health Zones around Butembo. This situation did not allow us to collect data in the entire North Kivu province.

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