Leukocyte Profile of Children Hospitalized in Neonatology Services for Suspected Infection in Kinshasa City, Democratic Republic of the Congo

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ABSTRACT

Neonatal infection (NI) remains a public health problem of concern because of its frequency and severity, which is related to the immuno-incompetence of the newborn and the risk of mortality, which is in the order of 10% to 30%. According to the World Health Organization (WHO), 30 to 40% of these newborn deaths are due to neonatal infections of bacterial origin. The present work was initiated with the aim of establishing the leukocyte profile of sick newborns with hyperthermia or hypothermia, in neonatology services for a better management of the newborn. The cross-sectional study was conducted in Kinshasa, capital of the Democratic Republic of the Congo (DRC) of a period from January 01 to December 31, 2018 with a sample consisting of 218 newborns from 0 to

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29 days admitted in the neonatology service. The software Microsoft Excel 2010 and SPSS for Windows version 22.0 served us in the encoding and analysis of data. The results obtained in this study presented the cells of the white lineage, then explained the infections in neonatology while examining the pathological variations of the different types of white blood cells. This study also showed that there is a lack of concordance between the clinical (181 or 83% of newborns) and biological (126 newborns with infection or 57, 8%) with statistically significant evidence.

1. INTRODUCTION

The hemogram is the quantitative (count) and qualitative (formula) analysis of the figurative elements of the blood (erythrocytes, leukocytes and platelets). The data from this analysis change profoundly during the first years of life and reflect the different stages of development. The physiological variations are proportional to the degree of prematurity. These differences are related to the developmental conditions during fetal life, to the complex interactions between the fetus and the mother, and to the changes necessary to adapt to extra-uterine life. In the neonatal period, the morphology of the blood cells presents some particularities that are worth recalling in order facilitating the distinction between physiological and pathological situations [1]. Neonatal infection (NI) is a biological phenomenon related to the complex interaction between a microorganism and the human host from birth to 29 days of age [2]. It remains pathology of concern because of its frequency and severity. Its frequency is estimated at 2 to 3% of live births [3]. Its seriousness is linked to the immuno-incompetence of the newborn and the risk of mortality, which is in the order of 10% to 30% depending on the series [4]. According to WHO (World Health Organization) data (98%) occur in developing countries [5], 30 to 40% of these deaths in the first four weeks of life are due to neonatal infections of bacterial origin [2]. It remains the leading cause of child mortality in the world, mainly during the neonatal period. Five million children die each year from neonatal infection. In African newborn, the particularity of the hemogram is a slight leukopenia with neutropenia compared to the Caucasian race; but this difference is not found in African newborns [6]. Many factors like social environment, prematurity, lifestyle and the mode of delivery have a negative impact on the hematological parameters of the newborn. In view of this problem, we wondered whether the clinical diagnosis made by the physician is in agreement with the one established by taking into account the discriminative examinations of orientation of the haemogram, precisely the leucocyte profile during a neonatal infection. The present study was carried out with the aim to establish the leukocyte profile of sick newborns with hyperthermia or hypothermia, in neonatology services for a better management of the newborn by associating clinical parameters with biology results.

2. METHODOLOGY

The cross-sectional study was conducted in Kinshasa, capital of the Democratic Republic of the Congo (DRC) from January 01 to December 31, 2018. The sample consists of newborns from 0 to 29 days admitted to the neonatology service came from all the communes of the city province mainly from the peripheral neighborhoods including the Musoso and Kingabua neighborhoods in the commune of Limete, the sitasi neighborhood in the commune of Barumbu, the television neighborhood in the commune of Kimbanseke. Sick newborns of female or male sex hospitalized in neonatology services for suspected infection and having a complete clinical file, presenting hypothermia or hyperthermia in addition to other clinical signs were included in this study, while newborns admitted in neonatology with an incomplete file were not included in the study. Neonates with visible congenital malformation and, those with trauma at delivery were excluded in our study. Regarding the sample size, we used the Fischer formula to have a suitable sample for the validation of the results and for the respect of the medical principles of the research according to François [7].

$$n \geq \frac{Z^2(p)(1-p)}{d^2}$$

n=sample size, Z=1.96 confidence coefficient, P=15% prior prevalence, d=0.O5 degree of desired absolute precision. The formula gives n+15% of non-responders.

$n \geq \frac{1.96^2(0.15)(1-0.15)}{0.05^2} \geq 194$; n=194+29.1=223. There were five incomplete forms; the sample size was 223-5=218

After encoding and validation of the clinical and hematological data (leukocyte count) of newborns hospitalized for suspected infection in KINSHASA, the data were entered using Microsoft Excel 2010. Systematic cleaning of the file was carried out using the completeness test and the consistency test in order to harmonize and validate the data. The analyses were carried out with the SPSS for Windows software version 22.0. The different variables were described using statistics such as the mean ± standard deviation for continuous quantitative variables with a symmetrical distribution as well as the median with the interquartile range (IQR), for those with a non-Gaussian distribution. Categorical variables were described as relative (%) and/or absolute G/L (n) frequency. For the analyses, the comparison of the means of two groups was done with Student's t tests; whereas Pearson's Chi-square or Fisher's Exact test was used for the comparison of proportions. The diagnostic agreement between the clinician's and the biologist's was investigated by the McNemar test with calculation of Kappa. The p value < 0.05 defined the threshold of statistical significance. In addition to hyperthermia/ hypothermia, other clinical signs such as icterus, respiratory distress, metabolic disorder, asthenia, dyspnea, cyanosis, neurological disorder, coughing, and vomiting were used to complete infections diagnosis in the newborn.

3. RESULTS

3.1 Sociodemographic Characteristics

The results of the socio-demographic characteristics presented in this study are those related to age, sex, place of residence, and mode of delivery as shown in the various graphs and tables in this paragraph. The figures below show the distribution of children by age (Fig. 1) and by sex (Fig. 2).

Fig. 1 shows that the study population was abnormally distributed (non-Gaussian distribution) and the vast majority of the study subjects were between 0 and 10 days of age. With regard to sex (Fig. 2), the figure shows that the male sex predominates over the female sex with proportions of 57.3% and 42.7% respectively and a sex ratio M/F of 1.3.
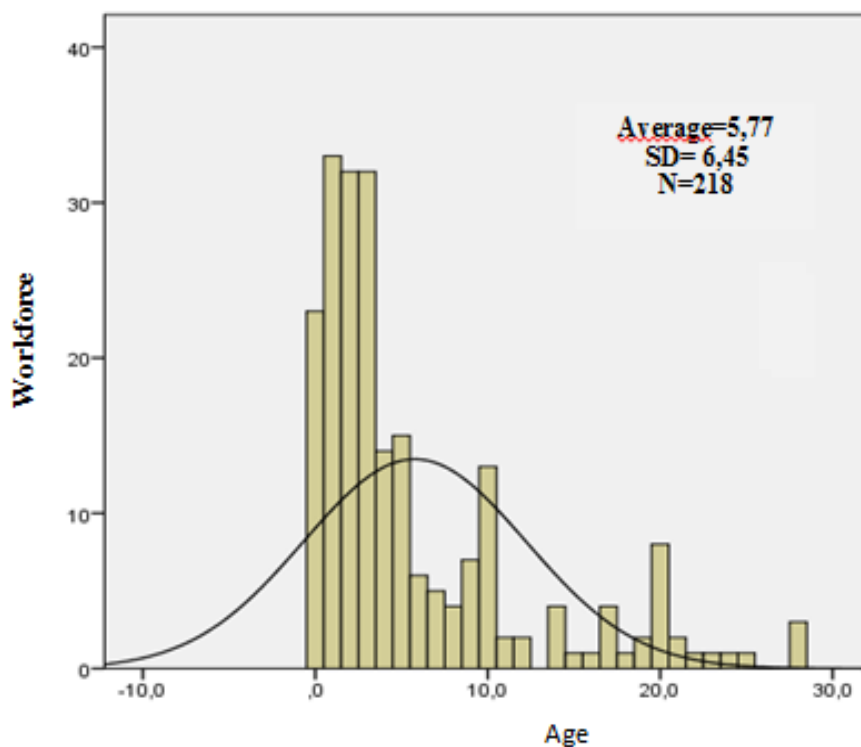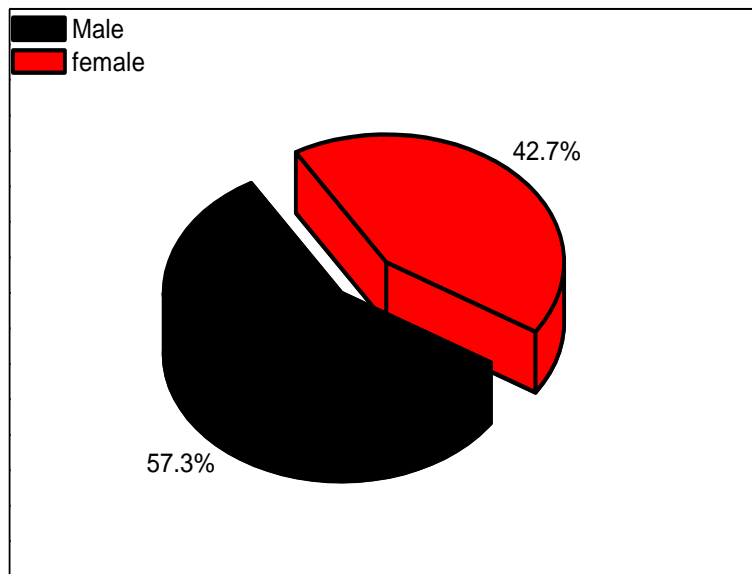

Fig. 1. Distribution of children by age

Fig. 2. Distribution of children by gender

The results on the distribution of patients by age are shown in the following Table 1.

Table 1. Age distribution of patients

Age (days)	Nombers	Percentage
Measures of trend and dispersion		-
Mean ± SD	5.8±6.5	-
Me (EIQ)	3.0 (2.8-4.6)	-
Extremes	0-28	-
Age range in days		
0-2 days	88	40.4
3-6 days	67	30.7
7-12 days	33	15.1
>12 days	30	13.8
Total	218	100.0

The results in this table show that the median age of the patients is 3 days with the extremes ranging from 0 to 28 days (mean age 5.8 days). The age range of 0-2 days is the most predominant with a proportion of 40.4% followed by 3-6 days (30.7%). Early-onset infection concerns 88 newborns or 40.4%. The results on the distribution of patients according to the commune of residence are shown in Table 2 below. The results obtained show that the patients came from all the communes of the city and province of Kinshasa with an unequal distribution (Table 2). The majority came from the communes of Kimbanseke and Limeté (9.6% respectively) and N'djili (8.7%).

Tables 3, 4 and 5 provide information on the mode of delivery, type of pregnancy and characteristics of the newborn. As can be seen (Table 3), eutocia is the most frequent mode of delivery (52.8%), followed by cesarean section and dystocia (25.2% and 22% respectively). Table 4 shows that the monofetal type of pregnancy is the most frequent with 91.7% compared to the twin type which represents only 8.3%. In Table 5, full-term babies represent 90.4% while premature babies are only 21, i.e. 9.6%.

3.2 Clinical Characteristics of Patients

The clinical characteristics of the patients in our study are the clinical signs noted by the clinician during the consultation and the diagnosis made by the pediatrician.

Table 2. Distribution of patients by municipality of residence

Municipality of residence	Number (n=218)	Percentage
Kimbanseke	21	9.6
Limete	21	9.6
N'djili	19	8.7
Barumbu	18	8.3
Kinshasa	16	7.3
Kalamu	15	6.9
Masina	14	6.4
Bumbu	11	5.0
Lemba	10	4.6
Ngaliema	10	4.6
Kisenso	9	4.2
Bandalungua	7	3.2
Kasa-vubu	6	2.8
Lingwala	6	2.8
Mont Ngafula	6	2.8
Gombe	5	2.3
Selembao	5	2.3
Makala	4	1.8
Ngaba	4	1.8
Ngiringiri	4	1.8
Matete	3	1.4
Kintambo	2	0.9
Maluku	1	0.5
N'sele	1	0.5

Table 3. Mode of delivery

Variables	Number (n=218)	Percentage
Mode of delivery		
Eutocie	115	52.8
Cesarean section	55	25.2
Dystocia	48	22.0

Table 4. Type of pregnancy

Variables	Number (n=218)	Percentage
Type of pregnancy		
Monofetal	200	91.7
Twin pregnancy	18	8.3

Table 5. Characteristics of the newborn

Variables	Number (n=218)	Percentage
Type of Newborn		
Full term newborn	197	90.4
Preterm	21	9.6

Table 6. Distribution of clinical signs of the patients

Signs	All n=218	Male n=125	Female n=93	P
T°>37°	165(75.7)	96(76.8)	69(74.2)	0.387
Fever	155(71.1)	91(72.8)	64(68.8)	0.311
T°≤ 36°	174(20.2)	24(19.2)	20(21.5)	0.400
Icterus	33(15.1)	19(15.2)	14(15.1)	0.566
Respiratory distress	27(12.4)	17(13.6)	10(10.8)	0.339
Metabolic disorder	23(10.6)	10(8.0)	13(14.0)	0.116
Asthenia	19(8.7)	7(5.6)	12(12.9)	0.034
Dyspnoea	19(8.7)	9(7.2)	10(10.8)	0.248
Cyanosis	8(3.7)	5(4.0)	3(3.2)	0.532
Neurological disorder	8(3.7)	5(4.0)	3(3.2)	0.532
Coughing	8(3.7)	6(4.8)	2(2.2)	0.258
Vomiting	7(3.2)	2(1.6)	5(5.4)	0.120
Polypnoea	6(2.8)	5(4.0)	1(1.1)	0.191

3.2.1 Clinical signs

Table 6 shows the distribution of the clinical signs of the patients.

From this Table 6, it appears that patients with temperature >37°c, fever, temperature equal to 36°c and jaundice were in the majority. We did not notice a statistically significant difference between the male and female sex except for physical asthenia which was higher in the female sex (p=0.034)

3.2.2 Pediatric diagnoses

Fig. 3 below provides information on the distribution of probable diagnoses.

This Fig. 3 presents the pediatrician's diagnosis which shows a dominance of children suffering from infection (83%), against 11.5% of other pathology, 2.3% of malaria and 3.2% of perpetual asphyxia.

3.3 Hematological Characteristics

The haematological characteristics retained are the values of the white blood cell count and the leucocyte formula of the newborns included in our study after analysis. These characteristics are shown in Table 7. This table (Tabl.7) shows that the mean values of WBC/L, Neutrophil, Monocyte Lymphocyte and Eosinophil were 13.9±6.0 G/L, 64.0±16.4%, 32.6±16.1%, 2.9±1.9% and 2.2±0.6% respectively. The comparison between male and female mean WBC values was not statistically different.
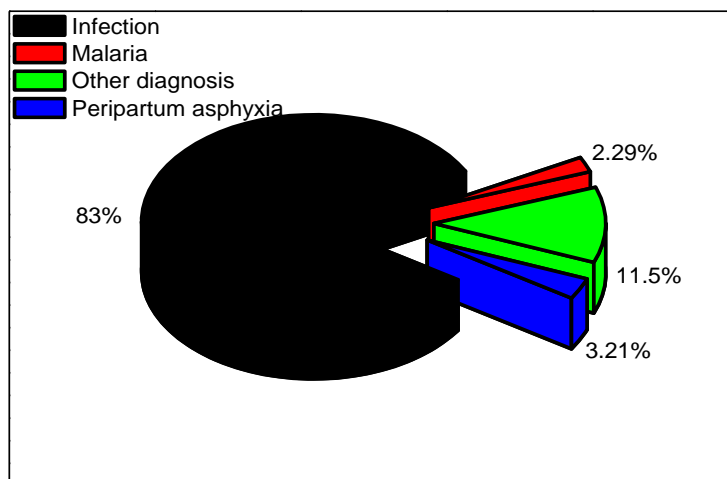
Fig. 3. Distribution of probable diagnoses

Table 7. Leukocyte characteristics in relative and absolute terms per G/L

Variables	N	All	Male	Female	P
GB/GL	216	13.9±6.0	13.9±6.1	14.0±5.9	0.960
N%	218	64.0±16.4	64.6±17.2	63.3±15.3	0.547
N/GL	218	9.1±5.3	9.3±5.5	9.0±4.9	0.713
L%	217	32.6±16.1	32.3±16.9	32.8±14.8	0.824
L/GL	217	4.2±2.5	4.2±2.6	4.3±2.4	0.861
M%	191	2.9±1.9	2.8±1.9	2.9±1.9	0.734
M/GL	187	0.40±0.04	0.42±0.07	0.37±0.05	0.360
E%	69	2.2±0.6	1.9±0.5	2.6±0.8	0.151
E/GL	62	0.28±0.6	0.18±0.07	0.42±0.06	0.142

3.4 White Blood Cell Count

The interpretation was performed using the reference value provided in the literature. The results of the hematological interpretation are shown in Table 8.

From this table it can be seen that the most pathological leukocyte count in neonates is neutrophilia (44.5%), followed by lymphopenia (18.8%), lymphocytosis (16.5%), non-pathological leukocyte count (13.8%), monocytopenia (10.1%), neutropenia (4.6%), hyperleukocytosis (4.1%), leukopenia (2.3%), and eosinophilia (1.4%) respectively.

3.5 Diagnosis of Certainty

The results on the most probable diagnosis of neonatal infection according to age based on biological arguments and especially the correlation with the pediatrician's diagnosis are represented in Table 9 below. The results show that the frequency of lymphocytosis and neutrophilia was significantly higher in older neonates (7-28 days), while lymphocytosis was significantly higher in younger neonates (0-6 days). The frequency of neutrophilia and lymphopenia increased significantly with the age

of the newborn (p<0.001), whereas the frequency of lymphocytosis decreased with increasing age of the newborn (p=0.025) (Table 9). The diagnosis made was not different between the two sexes. This difference was not statistically significant (Table 10).

Table 11 shows the relationship between the clinic and the laboratory, from which it can be seen that the frequency of normal WBC count was higher in patients diagnosed with infection by the pediatrician, while lymphopenia was higher in patients diagnosed by the pediatrician without infection, i.e. as other pathology (p=0.022)

Fig. 4 provides information on the concordance between the clinical diagnosis and the blood count result.

In this figure the clinician's diagnosis and the laboratory diagnosis are illustrated. From this figure, it appears that the frequency of infection diagnosed after the WBC examination was significantly lower than that diagnosed by the pediatrician (57.8% vs 83%, p<0.001). The statistical relationship between the concordance of probable and definite diagnosis is shown in the following Table 12.

Table 8. Hematological interpretation of results

Variables	Number (n=218)	Percentage
Normal	30	13.8
Neutrophilia	97	44.5
Lymphopenia	41	18.8
Lymphocytosis	36	16.5
Monocytopenia	22	10.1
Neutropenia	10	4.6
Hyperleukocytosis	9	4.1
Leukopenia	5	2.3
Eosinophilia	3	1.4
Total	218	100

Table 9. Diagnosis of certainty according to age

Variables	0-2 days n=88	3-6 days n=67	7-12 days n=33	>12 days =30	P
Neutropenia	6(6.8)	1(1.5)	1(3.0)	2(6.7)	0.406
Lymphopenia	11(12.5)	6(9.0)	16(48.5)	8(26.7)	<0.001
Neutrophilia	18(20.5)	43(64.2)	17(51.5)	19(63.3)	<0.001
Hyperleukocytosis	4(4.5)	3(4.5)	2(6.1)	0(0,0)	0.733
Lymphocytosis	20(22.7)	13(19.4)	2(6.1)	1(3.3)	0.025
Leukopenia	4(4.5)	1(1.5)	0(0.0)	0(0.0)	0.256
Lymphocytosis	9(10.2)	9(13.4)	1(3.0)	3(10,0)	0.392
Eosinophilia	1(1.1)	0(0.0)	1(3.0)	1(3.3)	0.517

Table 10. Blood count results by gender

Variables	Male (n=125)	Female (n=93)	P
Normal	18(14.4)	12(12.9)	0.456
Neutropenia	8(6.4)	2(2.2)	0.122
Lymphopenia	26(20.8)	15(16.1)	0.244
Neutrophilia	56(44.8)	41(44.1)	0.513
Hyperleukocytosis	7(5.6)	2(2.2)	0.180
Lymphocytosis	23(18.4)	13(14.0)	0.248
Leukopenia	2(1.6)	3(3.2)	0.363
Lymphocytosis	12(9.6)	10(10.8)	0.476
Eosinophilia	0(0.0)	3(3.2)	-

Table 11. Clinical diagnosis and diagnosis of certainty

Variables	Other pathologies (n=37)	Infections (n=181)	P
Normal	1(2.7)	29(16.0)	0.020
Neutropenia	1(2.7)	9(5.0)	0.470
Lymphopenia	12(32.4)	29(16.0)	0.022
Neutrophilia	18(48.6)	79(43.6)	0.352
Hyperleukocytosis	2(5.4)	7(3.9)	0.470
Lymphocytosis	6(16.2)	30(16.6)	0.589
Leukopenia	0(0.0)	5(2.8)	-
Monocytopenia	3(8.1)	19(10.5)	0.466
Eosinophilia	1(2.7)	2(1.1)	0.429
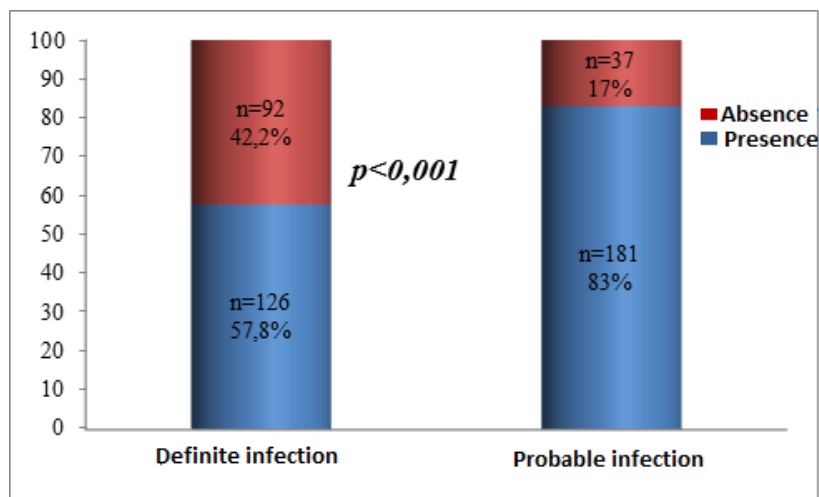
Fig. 4. Concordance between probable diagnosis and WBC result (certainty)

Table 12. Statistical relationship between the concordance of probable and certain diagnosis

Variables	N	%
Concordance infection	102	46.8
Concordance non-infection	13	6.0
Negative discordance	79	36.2
Positive discordance	24	11.0

Kappa = 0.153 (0.123-0.261)

We did not find statistical agreement between the pediatrician's diagnosis and that after WBC examination (kappa = 0.153). There is a discordance overall. On the other hand, a diagnostic concordance between the diagnosis of the pediatrician and the biologist was noted in only 46.8% of patients, a non-infectious concordance in 6%.

4. DISCUSSION

The present non retrospective cross-sectional study was conducted in Kinshasa city from 1/1/2018 to 31/12/2018 on 218 newborns hospitalized for suspected infection and presenting either hyperthermia or hypothermia in addition to other clinical signs. The limitations of the study were the data collection; especially that pediatricians and nurses had not been sensitized to the importance of the completeness of the data concerning the mother and the newborn. In addition to hyperthermia (75.7%)/hypothermia (20.2%), other clinical signs such as icterus (15.1%), respiratory distress (12.4%), metabolic disorder (10.6%), asthenia (8.7%), dyspnea (8.7%), cyanosis (3.7%), neurological disorder (3.7%), coughing (3.7%) and vomiting (3.2%) were also associated to the infections in the newborn. Thus, the establishment of diagnosis scores combining biological parameters as well as the blood formula would increase the predictive probability of infection in newborn. The results of this study permeated to differentiate the clinical neonatal infections and other pathologies through the variation of white blood cells. This study demonstrated that the white blood cell profile varied in quantity according to the type of aggression and corroborate with the work of Greenberg & Yoder who found similar results [8].

Regarding the socio-demographic characteristics we had as median age three days, while Gertrude speaks of the range of 0 to 2 days that is most affected and is hospitalized in neonatology [wwwpanafricanparliament.org]. The male sex was the most represented with a sex ratio of 1.3. These results are similar to those of Kambale [9] who found a ratio of 1.4 in a study conducted in South Kivu in DR Congo.

According to infection origin, there is a correlation between residence and the occurrence of the disease statistically proven in this work. These results corroborate with those of Danho-Bassimbe [10] who stated that an unhealthy environment (like the lack of breast care) was one of the causes of maternal-fetal infection. The mode of eutectic delivery by vaginal route was the most represented; unfortunately capable of vertical transmission and mothers and newborns from poor families are the most vulnerable as confirmed by Assoumanide in Lubumbashi, DRC [11]. Temperature is one of the markers we used. Fever was the most common. These results confirm those obtained by Fanny Robert in Toulouse in [12]. Finally, the pediatrician's diagnosis indicated 83% neonatal infection, which is similar to Abdellatif, who found 83% presumption of neonatal infection in a 2010 study in Morocco [13].

Biological interpretation of our results showed a frequency of neutrophilia and lymphocytosis in 0-2 day old neonates which illustrates the presence of early onset infection at 18%. We had 16% maternal-fetal infection in Côte d'Ivoire and Bobossi in Central African Republic found 28.4% of early neonatal infection cases in 2015 [14].

In our study, the diagnostic concordance between the diagnosis of the pediatrician and the biologist was noted in only 46.8% of newborns, which shows that the newborns who had an infection were 126 or 57.8%, while the pediatrician suspected 181 newborns or 83% of newborns admitted for infection.

5. CONCLUSION

The present study was initiated with the aim of establishing the leukocyte profile of sick newborns with hyperthermia or hypothermia, in neonatology services for a better management of the newborn and we conclude from the results of

this study that there is a lack of concordance between clinical and biological diagnosis with statistically significant evidence (kappa=0.153).

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline Patient's consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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