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Hematological Profile of Newborns Hospitalized for Neonatal Bacterial Infection in the Neonatology of the Pediatric Department of Gabriel Toure Teaching Hospital Bamako, Mali

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Abstract

The blood count is an easily achievable routine exam and will it have specifics in the event of a neonatal bacterial infection? Hence, the present study with the objective of determining the profile of the hemogram of newborns hospitalized for early bacterial neonatal infection. **Material and methods:** This was a cross-sectional study that took place from June 27 to September 03, 2016 in the neonatology department of teaching hospital Gabriel Toure. Included were all neonates hospitalized for early neonatal bacterial infection (ENBI) and who had a blood count. **Results:** We included 227 patients, 64.8% of whom were premature. The sex ratio was 1.4. The infants were less than 24 hours old in 93.6% of the cases. The mean hemoglobin level was 16.435 g/dl [8.8 - 22.26]. Erythrocytopenia was found in 18.5% of cases. Anemia was present in 17% of newborns. The average leukocyte was $15.228 \cdot 10^3/mm^3$ [1.4 - 72]. Hyperleukocytosis and leukopenia were found in 12.32% and 6.6% respectively. Neutropenia and lymphopenia were present in 14.5% and 30.8%. There was a correlation between leukocytosis of negative blood cultures (23/27) ($p = 0.030$). For Neutrophils, neutrophilia was more observed in term neonates and neutropenia in premature infants ($p = 0.03$). Monocytosis was present in 13.6% of cases. One quarter (25.5%) of newborns had thrombocytopenia. **Conclusion:** Hematological variations did not allow a specific profile of newborns hospitalized for early neonatal bacterial infection to be identified.

Keywords

Hematological Profile, Newborns, Early Bacterial Neonatal Infection

1. Introduction

The hemogram or blood count (CBC), is the quantitative (counting) and qualitative (formula) analysis of the figured elements of blood (erythrocytes, leukocytes and platelets) [1]. The blood count data change profoundly during the first years of life and reflect the different stages of development [1]. The three spinal lines can be affected during neonatal infection, the most interesting abnormalities for the diagnosis of the infection concern the grainy line. However, in addition to variations linked to gestational age, there are significant physiological changes in this line during the first days of life [2]. Early neonatal bacterial infection (ENBI) is a heavy burden of high morbidity and mortality [3]. It remains a major public health problem. According to a report by the World Health Organization (WHO), infection is the number one killer of children worldwide, mainly during the neonatal period. Five million children die each year of neonatal infection. The vast majority of these deaths (98%) occur in developing countries. It is estimated that neonatal bacterial infection accounts for 30% - 40% of these deaths [4]. In Mali, neonatal infection occupies the second cause of death after prematurity [5] [6]. Clinical signs of neonatal infection are not specific because they are found in many neonatal conditions. As a result, the diagnosis of bacterial neonatal infections is based on bundles of clinical arguments and laboratory examinations including standard microbiological tests (blood, cerebrospinal fluid and urine), hematological and biochemical tests. In developed countries, the identification of the pathogen by blood cultures which confirms the clinical diagnosis has a high specificity [7] [8]. This is not the case in developing countries [7]. The complete blood count and different leukocyte dosages have relatively variable specificity for the diagnosis of bacterial neonatal infection. During bacterial infections, the bone marrow releases an increasing number of neutrophils into the blood, allowing neutrophils to migrate to the infected site. This overproduction of neutrophils did appear immature cells in the circulation, this process is called "left shift" [9] [10]. This discovery proved useful for the early diagnosis of bacterial infection. Thus in addition to the clinical signs, the blood count remains a routine examination in our service. Determining a hematological profile of infected newborns could contribute to early management in the absence of other expensive examinations. The blood count being an easily achievable examination, will it present specificities in case of bacterial neonatal infection? It is with this vision that this work was initiated with the objective of establishing a hematological profile of newborns hospitalized for early neonatal bacterial infection in the neonatology department of the Gabriel Toure teaching hospital.

2. Material and Methods

The study took place in the neonatology department of the Pediatrics department of the Gabriel Toure teaching hospital of Bamako, with an average reception capacity of 89 beds and an average admission of 3900 per year. We carried out a cross-sectional study, in all newborns between 0 - 72 hours of age who will be hospitalized for probable early neonatal bacterial infection in the department between June 27 and September 03, 2016 (*i.e.* over a period 70 days) and having a blood count. We included in our study any newborn whose interrogation found one or more associated amnesic criteria and or any clinically symptomatic newborn with no other obvious cause within 72 hours of life [2]. We did not include neonates from 0 to 72 hours who did not have a complete blood count.

Conduct of the study: each newborn admitted to the service was registered and subjected to a thorough clinical examination. The blood count was made at H12 of life. In addition, other examinations relating to neonatal bacterial infection have been requested, in particular blood culture and C-reactive protein.

Thus the parameters studied were the socio-demographic characteristics of the parents (age, marital status, profession and level of education), the characteristics of the newborns (age, birth term, gender, clinical signs ...) and biological characteristics (blood count, C-reactive protein, blood culture).

We have adopted the following definitions [11] [12]:

Clinical parameters:

- Normal body temperature of the newborn: 35˚C to 37.8˚C.
- Hypothermia: temperature below 35˚C.
- Fever: temperature above 37.8˚C.
- Polypnea: respiratory rate greater than 60 cycles/minute.
- Bradypnea: respiratory rate less than 30 cycles/minute.

Parameters of the hemogram: According to the norms of the Malian newborn Diallo D [13].

- Leukocytosis: white blood cell count > 23,700/mm^3.
- Leukopenia: white blood cell count < 7200/mm^3.
- Lymphopenia: <1960/mm^3.
- Lymphocytosis: >9420/mm^3.
- Neutrophilia: >14,220/mm^3.
- Neutropenia: <3070/mm^3.
- Anemia: hemoglobin level < 11.2 g/dl.
- Polycythemia: hematocrit > 65%.
- Microcytic: <91 fl.
- Macrocytic: >112 fl.
- Hypochromic: <31.6 pg/cell.
- Normochromic: 31.6 - 36.9 pg/cell.
- Thrombocytopenia : platelet count < 150,000/mm^3.
- Severe thrombocytopenia: platelet count < 50,000/mm^3.
- Thrombocytosis: platelet count > 450,000/mm^3.
- **Confirmed bacterial neonatal infection** was defined as the presence of

clinical signs of infection and positive specimens (blood, cerebrospinal fluid, urine, tracheal suction fluid).

- **The probable neonatal infection** of any clinically symptomatic newborn without any other obvious causes in the first 48 years of life must have evoked an ENBI. 2017 HAS Recipes.

2.1. Data Processing

After collection on a survey sheet. The data entry was done on the software Epi info version 3.5.1 and analyzed on the software SPSS 20.0. Ficher's Chi square statistical tests were used to compare the qualitative results, a value of $p < 0.05$ was considered significant.

2.2. Ethical Considerations

The research was approved by the Service Ethics Committee and informed consent was also obtained from the parents of all newborns.

3. Results

During the study period, 227 newborns with a complete blood count were included.

3.1. Sociodemographic Characteristics of Parents

Almost half or 49.3% of the fathers were between 27 - 35 years of age with an average age of 34.67 and extremes of 19 - 68 years. The vast majority, 93% were married. Workers represented the majority of the sample (51.1%), followed by traders in 26.9%. Almost a third (34.4%) were out of school and 42.7% had not passed the basic level. Concerning the mothers, the majority were between 18 and 35 years old (54.2%), with an average of 24.45 years and extremes 14 and 45 years. Housewives accounted for 77.5%. And 39.2% were uneducated, nearly half (48.4%) did not have a basic degree.

3.2. Clinical Features of Newborns

The source of newborns, the majority of patients were 42.8% were referred by referral health centers (RHC), followed by births "inborn" in 26.4%. We observed a male predominance with a sex ratio of 1.4. For admission, almost all 93.8% were admitted before their 24th hour of life, premature birth accounted for 64.8% of the sample and 34.8% were born at term. The baseline was prematurity in 56.8%, followed by perinatal anoxia and respiratory distress in (19.8%) and (13.4%), respectively. The clinical manifestations found were mainly respiratory and neurological signs (70%) and (46.3%) (**Figure 1**).

3.3. Biological and Bacteriological Characteristics of Newborns

CRP returned positive in 31 infants (13.7%) and blood culture increased in 34 patients (15%). The main bacteria isolated were Gram-positive cocci (*Staphylococcus aureus* in 14 patients) and Gram-negative bacilli (*Klebsiella pneumoniae*

in 5 patients and *Escherichia coli* in 4 patients, *Acinetobacter* in 4 patients).

The mean hemoglobin level was 16.435 g/dl [8.8 - 22.26]. The abnormalities observed were: for the erythrocyte line, erythrocytopenia associated with anemia was observed in 16.7% of newborns and polycythemia in 2.2% of patients. The anemia was microcytic in 6.2% and hypochromic in 8.4% of the cases. Regarding the leukocyte lineage, leukocytosis was found in 12.3% of neonates and leucopenia in 6.6% of cases. The neutrophil abnormalities found, neutrophilia in 16.7% of patients, neutropenia in 14.5%. For lymphocytes we found lymphopenia in 30.8% of newborns and lymphocytosis in 11% of cases. Monocytosis was found in 33.9% of patients and 25.1% had monocytopenia. One-quarter of the patients 58 (25.6%) had thrombocytopenia and nearly half (28 out of 58) died (Figure 2).

By doing uni-varied analysis with the abnormalities of the first line affected

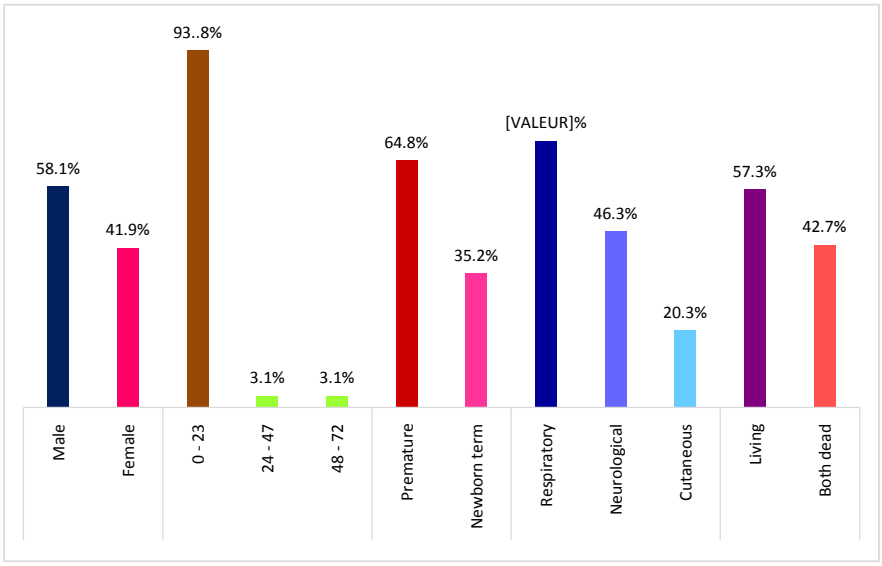

Figure 1. Clinical features of newborns.

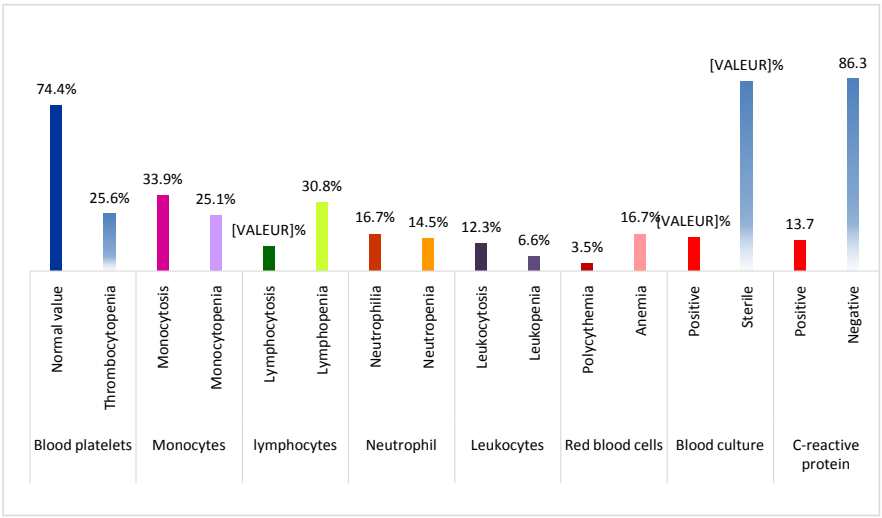

Figure 2. Biological and bacteriological characteristics of newborns.

during a bacterial infection that is the leukocyte lineage with a focus on neutrophils. We observed that leucopenia is observed mainly in term newborns (12 out of 15 cases) and that it is observed in the first 24 hours of life (14 out of 15 cases) with a negative CRP (11 out of 15 cases). And 50% of these patients died (8 of 16). For leukocytosis, it occurs regardless of the birth term especially in the first 24 hours of life (23 out of 27 cases) associated with a negative CRP in the 25 out of 27 neonates; only its association with negative blood cultures was statistically significant ($p = 0.030$) (Table 1).

Neutropenia is mainly observed in premature newborns (25 out of 33) occurring within the first 24 hours (30 out of 33) with CRP is negative (24 out of 33) and these associations are statistically significant with ($p = 0.003$) ($p = 0.002$) and ($p = 0.04$). Neutrophilia was mainly observed in term newborns (23 cases out of 38) of early onset before their first day of life (32 cases out of 37) (Table 2).

Table 1. Relationship between leukocytes and different elements.

Leukocytes		Normal	Leukopenia	leukocytosis	Probability
Term	Premature	64	3	12	*p*: 0.436
	Newborn term	120	12	15	
Age in hour	0 - 23	176	14	23	*p*: 0.090
	24 - 47	4	0	3	
	48 - 72	5	1	1	
C-reactive protein	Negative	166	11	25	*p*: 0.229
	Positive	25	4	2	
Exit modality	Living	108	8	14	*p*: 0.757
	Both dead	77	8	13	
Blood culture	Positive	24	6	4	*p*: 0.030
	Negative	161	9	23	

Table 2. Relationship between polymorphonuclear neutrophils and different elements.

Neutrophil polynuclear cells		Normal	Neutropenia	Neutrophilia	Probability
Term	Premature	107	25	15	*p*: 0.003
	Newborn term	49	8	23	
Age in hour	0 - 23	151	30	32	*p*: 0.002
	24 - 47	2	0	5	
	48 - 72	3	3	1	
C-reactive protein	Negative	137	24	35	*p*: 0.047
	Positive	19	9	3	
Exit modality	Living	92	15	23	*p*: 0.341
	Both dead	64	18	15	
Blood culture	Positive	19	8	7	*p*: 0.145
	Negative	137	25	31	

Neonatal bacterial infection was confirmed in 34 patients (15%) and considered likely in 193 newborns (85%). To become immediate, 42.7% of newborns died.

4. Discussion

4.1. Methodological Approach

Approach we conducted a cross-sectional study. This type of study makes it possible to take stock of a given question in a given environment during a given period taking into account the realities of the field (the hospital). We used data from a survey we conducted in the neonatology department. The data for this survey were collected according to a prospective collection from a standardized survey sheet from the pregnancy monitoring booklet, the link sheet in the case of transfer, from the mother and/or companions and medical records.

4.2. Limits and Difficulties Encountered

During our study, we encountered problems such as the reluctance of mothers to answer questions deemed sensitive and personal. All newborns could not be in the study for lack of means and technical problems to carry out the assessments. Despite these limitations we were able to do our work.

In our sample, the sex ratio was 1.4; this predominance of the male sex has been found in several studies [7] [14] [15] [16]; without scientific explanation found.

The final diagnosis of bacterial neonatal infection is based on the culture of blood and or cerebrospinal fluid and takes at least 24 to 72 hours. In our study, of the 227 newborns with probable bacterial neonatal infection, it was confirmed only in 34 patients (15%) by the positivity of blood cultures. The most frequently isolated germs were: *Staphylococcus aureus* 41.2% (14 cases), *Klebsiella pneumoniae* 14.7% (5 cases), *Escherichia coli* 11.8% (4 cases) and *Acinetobacter* 11.8% (4 cases). The study of N'guessan R. (2017) [17] found 13.8% of *Staphylococcus aureus* and 65.5% of coagulase-negative Staphylococcus. These constants make the peculiarities of neonatal bacterial infections in tropical environments with a high prevalence of S. aureus infections witnessing the level of precarious asepsis and hospital hygiene as well as the insufficiency of qualified nursing staff [18] [19]. It is the first germ responsible for nosocomial infections. Thus, Haley and Bergman [20] have demonstrated the existence of a significant relationship between the under-staffing of nursing staff and the asepsis conditions on the one hand and the frequency of *Staphylococcus aureus* infections in the intensive care unit. neonatal on the other hand. They found an infectious risk 16 times higher during periods of overload in care.

A large number of newborns (93.8%) were symptomatic before their first day of life. In literatures, the first clinical manifestations of neonatal bacterial infection very generally appear before the 72nd hour of life. What is found by Bhagyashree M. [21]. Premature babies are more susceptible to infection than those

born at term because of their weak immune systems, low immunoglobulin levels, low skin barrier, and low birth weight [22]. In our study, more than the majority (64.8% were premature and 35.2% of children born are full term). This susceptibility of premature newborns was found by Bhagyashree M [21]. Clinically, the main manifestations were respiratory and neurological signs. Buch A. C. *et al.* Find that respiratory problems are the most common [23].

The hematological anomalies found in our study were anemia in 16.7% of patients with a probable neonatal bacterial infection. In the literature, the occurrence of anemia is infrequent and late and is absolutely not specific [2]. Our result is superior to those found by Abdellatif H. in Morocco [24] who found 16 cases of anemia (8%). We observed 12.3% of the cases of hyperleukocytosis. In several African studies such as that of Folquet M. A. *et al.* (2016), found hematological disturbances such as anemia (25.9%), leukopenia (22.5%) and in that of EL-Yahyaouy I. (2018) found that term newborns with neonatal infection show anemia in 11.7%, leukopenia 9% and leukocytosis in 8.1% of patients [25] [26].

Leukocyte abnormalities have poor sensitivity and low positive predictive value, while other studies have shown that only the positive predictive value is low [27]. This can be explained by the fact that many non-infectious conditions may be associated with an abnormal number of leukocytes in the neonatal period. Likewise, Sucilathangam G. *et al.* also reported that the total number of leukocytes was normal in 12 of the 13 positive cultures [28]. In addition, neutropenia was observed in preterm infants and neutrophilia in full-term infants. Neutrophilia and lymphopenia show a bacterial infection, observation of these two abnormalities is correlated with a high rate of mortality [29] [30]. Nearly one in four patients had thrombocytopenia with nearly 50% of deaths in this group. Which shows that thrombocytopenia is a sign of gravity. It is frequently associated with severe sepsis and its association with the clinical picture constitutes a poor prognosis [21] [31]. This is explained by an increased destruction of platelets by sequestration secondary to infections and/or by a decrease in production secondary to the suppression of the bone marrow. It has a high sensitivity and specificity [21] [24] [31].

CRP is a good but late marker of infection. When an infection or tissue damage occurs, the immediate reaction of the body is to produce endogenous peptides by the liver. The synthesis of CRP is done within six hours of exposure to an infectious process and will increase within 24 to 48 hours. There may be an increase in CRP under certain non-infectious conditions such as in case of aspiration of meconium or in case of premature rupture of the membranes. There is no difference in the level of CRP in a context of confirmed or not infection [32] [33].

Of the 227 newborns who achieved CRP, it returned positive in 31 patients, or 13.7%, which is comparable to the value found by Shresta *et al.* [34] where the CRP returned positive in 15% of the cases; considerably lower than that of Chemsi M [35] in Morocco, which found a frequency of 67.3%.

5. Conclusion

Early neonatal bacterial infection remains a major concern in our service. At present, no biological marker is sensitive or specific enough to allow the diagnosis alone and initiate treatment. This is why the treatment is done on a range of clinical and biological arguments (the blood count, the C-reactive protein and blood cultures). Hematological variations did not allow a specific profile to be identified in early neonatal bacterial infection in our context.

Conflicts of Interest

We, the authors declare that we have no conflicts of interest in connection with this article.

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