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Haematological profile of apparently healthy term babies aged one day, three days and six weeks delivered in Sagamu, Nigeria

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Abstract *Background:* Normal values of haematological parameters are often required to assist with diagnosis and monitoring.
Objective: To determine the haematological indices of apparently healthy term babies on the first day, third day and sixth week of life.
Method: A longitudinal survey of the haematological parameters of apparently healthy Nigerian term infants was carried out between October 2007 and March 2008 using electronic devices.
Results: On the first day of life, the mean values were 46.3% for packed cell volume (PCV), 10.8×10^9/L for total white blood cell (TWBC) and 261.3×10^9/L for platelets. The mean values obtained on the third day of life included PCV of 43.3%, TWBC of 10.7×10^9/L and platelets count of 242.5×10^9/L. In the sixth week of life, the mean values of PCV, TWBC and platelets count were as follows: 32.0%, 8.8×10^9/L and 277.7×10^9/L respectively. The mean percentage neutrophil counts and lymphocyte counts were 56.8% and 38.7% respectively on the first day but were reversed to 34.6% and 63.4% respectively on the sixth week of life.
Conclusion: The mean values of the PCV and TWBC were highest on the first day of life and lowest in the sixth week of life whereas the mean values of platelets count showed a less consistent pattern over the same period.

Key words: Erythrocytes, Haematological indices, Leucocytes, Newborn, Platelets

Introduction

Haematologic problems are frequently encountered by paediatricians caring for sick newborn infants. Alterations in the haematopoietic system are most often reactive, secondary, and sometimes iatrogenic.[1] However, abnormal haematopoiesis may be a useful marker of underlying systemic diseases, including infections, asphyxia, genetic and metabolic disorders. Therefore, it is important to establish normal ranges of values for various haematological indices in the newborn. For instance, packed cell volume is particularly important because anaemia is one of the determinants of both morbidity and mortality in neonates.[1] Knowledge of the platelet count in an index neonate is of immense value in the evaluation of bleeding disorders.[2] The definitive diagnosis of neonatal sepsis for instance, is based on blood culture. However, it takes about 48 hours to obtain a preliminary report. On the other hand, leukocyte indices could provide a useful guide while anticipating a definitive result.[3] In addition, severe anaemia and thrombocytopenia may also be found in infants with neonatal sepsis.[3]

In addition to uniqueness of normal values, different workers have demonstrated age-related changes in various haematologic indices within the first few weeks of life.[4-8] Such knowledge is of great value in interpreting results of tests and in determining limits within which to accept the findings in an index patient as normal.

Several studies of healthy newborn infants in recent years have shown, however, that changes in haematological indices in the first few weeks of life follow a definite pattern and that normal values can indeed be defined for a given population.[4-6, 9]

The last study of haematological profile in term neonates from Western Nigeria was done three decades ago. Thus, the study was aimed at establishing the current pattern of haematological profile of babies delivered at Sagamu, South-West Nigeria.

Materials and Methods

A longitudinal study of the haematological parameters of apparently healthy term infants was carried out over a six month period (October 2007 to March 2008) at Olabisi Onabanjo University Teaching Hospital (O.O.U.T.H.), Sagamu. This hospital provides general and specialized paediatric and haematologic care for children delivered within Ogun State or referred from parts of Lagos and Ondo States.

The inclusion criteria included term, singleton deliveries while antepartum haemorrhage, caesarean delivery, overt bleeding, significant mechanical birth trauma, severe birth asphyxia, large cephalohaematoma, gross congenital malformations, features of intra-uterine infections and perinatal exposure to HIV were the exclusion criteria. Babies previously included in the study but who subsequently developed significant jaundice (defined as total serum bilirubin > 12mg/dl) or required blood transfusion were also excluded.

The sample size was derived from the formula ($n = (Z^2 \times S^2)/ B^2$ where Z represented the standard normal coefficient at 95% confidence interval (1.96), S represented the standard deviation and B represented the desired precision level expressed as half the maximum acceptable confidence interval width about the mean (0.05 or 5%). Using mean values for each haematologic parameter previously reported from other parts of Nigeria, [4, 5] the calculated total sample size was 144 but additional 36 babies were studied to allow for attrition. Overall, one hundred and eighty term singleton babies were recruited into the study. All the babies were delivered in the teaching hospital after an uneventful antenatal period. The babies were positioned at the level of the introitus during delivery and cord was clamped witin 30seconds of delivery.

Prior to the commencement of the study, ethical clearance was obtained from the Scientific and Ethics review Committee of the O.O.U.T.H. and written consent of the recruited mothers was also obtained.

One and half millilitre (1.5ml) of venous blood was drawn from the recruited infants between the second and sixth hour of life and on the third day of life while they were with the mothers in the postnatal ward of the hospital. Prior to discharge from the hospital, the mothers were counselled to breastfeed the babies exclusively and avoid nutritional supplements. They were also encouraged to reach the principal investigator on phone at the slightest indication of an illness in their babies. During the postnatal clinic visit, only babies who had remained healthy and exclusively breastfed since discharge from the hospital were re-included in the study. Thus, a third sample of venous blood was obtained at the age of six weeks during the postnatal visit.

These blood samples were preserved in Ethylene Diamine Tetra acetic Acid (EDTA) bottles. The blood samples were mixed gently to achieve good anticoagulation and were processed immediately after collection. The haematological parameters studied included the packed cell volume (PCV), erythrocytes count, haemoglobin concentration, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), nucleated red blood cells (nRBC), reticulocytes count, total white blood cells count (TWBC), differential white blood cells count and platelets count.

The haematological parameters were determined using the ADVIA® 60 Closed Tube (CT) Automated Haematology System[10] while the reticulocyte count was manually performed using newly prepared methylene blue as described by Dacie and Lewis.[11] This is because ADVIA® 60 closed tube (CT) Automated Haematology System [10] does not have this function.

Descriptive information like means, ranges, ratios, and standard deviation of continuous variables were derived as necessary.

Result

One hundred and eighty singleton term babies were recruited into the study at birth. However, owing to attrition, 173 and 142 babies were studied on the third day of life and the sixth week of life respectively. Seven babies could not be studied on the third day of life because they were prematurely discharged from the hospital against medical discharge. Of the 38 babies who defaulted at the sixth week of life, 4 (10.5%) declined further participation, 20 (52.6%) did not attend the clinic and could not be traced while

The remaining 14 (36.8%) had various medical problems such as haemorrhagic disease of the newborn, severe neonatal jaundice requiring exchange blood transfusion and severe sepsis.

The birth weight of the 180 babies ranged from 2.5kg to 4.0kg with a mean of 3.18 ± 0.42kg. Eighty-four (46.7%) of the babies were males while 96 (53.3%) were females with male-to-female ratio of approximately 0.9:1.

Red Cell Indices

The mean PCV on the first day of life (PCV-1) was 46.3 ± 7.2% while the mean PCV on the third day of life (PCV-3) and in the sixth week of life (PCV-6) were 43.3 ± 7.7% and 32.0 ± 4.8% respectively. (Table)

The mean haemoglobin on the first day was 0.9g/dl higher than the value obtained on the third day and it dropped further by 3.9g/dl in the sixth week. While The mean values of MCV, MCH and nRBC were highest on the first day, decreased slightly on the third day and were lowest in the sixth week. Table 1. The mean reticulocytes count was 3.5% on the first day, 2.6% on the third day and 2.7% in the sixth week.

Table 1: Red cell indices of the babies on the first day, third day and sixth week of life

Parameter	Day 1(n=180) Mean ± SD *(Range)*	Day 3(n=173) Mean ± SD *(Range)*	Week 6(n=142) Mean ± SD *(Range)*
PCV (%)	46.3 ± 7.2 *(30 – 68)*	43.3 ± 7.7 *(30 – 64)*	32.0 ± 4.8 *(23 – 48)*
Hb (g/dl)	15.4 ± 2.4 *(9.4 – 22.7)*	14.5 ± 2.6 *(8.0 – 22.1)*	10.6 ± 1.7 *(7.7 – 15.9)*
RBC (x 10^{12}/l)	5.1 ± 0.8	4.8 ± 0.9	3.9 ± 0.6
	(3.2 – 7.6)	*(2.7 – 7.5)*	*(1.3 – 5.9)*
MCV (fL)	91.6 ± 7.2 *(73.0 – 110.0)*	89.9 ± 6.8 *(74.0 – 104.0)*	80.4 ± 8.3 *(62.0 – 99.0)*
MCH (pg)	30.5 ± 2.6 *(24.0 – 36.0)*	29.9 ± 2.5 *(23.5 – 35.9)*	26.6 ± 2.8 *(20.8 – 34.1)*
MCHC (g/dl)	33.1 ± 1.4 *(25.9 – 36.1)*	33.0 ± 1.3 *(23.5 – 35.9)*	32.7 ± 1.3 *(25.9 – 36.7)*
nRBC (%)	4.3 ± 8.8	1.5 ± 4.5	0.6 ± 2.2
	(0.0 – 48.0)	*(0.0 – 30.0)*	*(0.0 – 20.0)*
Retic (%)	3.5 ± 1.4 *(0.0 – 7.1)*	2.6 ± 1.5 *(0.0 – 6.0)*	2.7 ± 1.7 *(0.0 – 8.4)*

Key: PCV Packed Cell Volume; Hb - Haemoglobin Concentration; RBC Red Blood Cells;
MCV - Mean Corpuscular Volume; MCH Mean Corpuscular Haemoglobin; MCHC - Mean Corpuscular Haemoglobin Concentration; nRBC nucleated Red Blood Cells; Retic Reticulocyte Counts

Table 2 describes the distribution of babies according to the PCV on the days of study. The PCV-1 of most babies (81.6%) ranged between 35% and 54% while only 3.9% had PCV-1 less than 35%. Similarly, most babies (80.3%) had PCV-3 ranging between 35% and 54% while a higher proportion (11.3%) had PCV-3 less than 35%. On the contrary, 73.2% of the babies had PCV-6 less than 35% and only 26.8% had PCV-6 ranging between 35% and 54%.

Table 2: Frequency of PCV ranges on the first and third days and the sixth week of life

PCV range (%)	Day 1 (n = 180)	Day 3 (n = 173)	Week 6 (n = 142)
< 35	7 (3.9)	20 (11.6)	104 (73.2)
35 – 44	66 (36.6)	77 (44.5)	36 (25.4)
45 – 54	81 (45.0)	62 (35.8)	2 (1.4)
55 – 64	25 (13.9)	14 (18.1)	0 (0.0)
≥ 65	1 (0.6)	0 (0.0)	0 (0.0)
Total	180 (100)	173 (100)	142 (100)

Key: PCV Packed Cell Volume

White Cell Indices

The mean values of TWBC on the first day, third day and in the sixth week were 10.8 × 10^9/L, 10.7× 10^9/L and 8.8 × 10^9/L respectively as shown in Table 3.
The mean percentage neutrophil count decreased from 56.8% on the first day, through 46.9% on the third day to 34.6% in the sixth week .

Table 3: Total and differential white cell count on Days 1, 3 and Week 6

Parameter	Day 1 (n=180) Mean ± SD *(Range)*	Day 3(n=173) Mean ± SD *(Range)*	Week 6 (n=142) Mean ± SD *(Range)*
TWBC (x 10^9/L)	10.8 ± 15.0 *(3.5 – 25.0)*	10.7 ± 3.8 *(3.5 – 24.3)*	8.8 ± 2.8 *(3.9 – 17.4)*
Neutr (% TWBC)	56.8 ± 10.9 *(22.0 – 76.0)*	46.9 ± 12.9 *(11.0 – 90.0)*	34.6 ± 11.5 *(14.0 – 78.0)*
Lymph (% TWBC)	38.7 ± 10.9 *(16.0 – 70.0)*	50.7 ± 12.9 *(10.0 – 89.0)*	63.4 ± 11.3 *(22.0 – 86.0)*
Baso (% TWBC)	0.0 ± 0.0 *(0.0)*	0.0 ± 0.0 *(0.0)*	0.0 ± 0.0
Mono (% TWBC)	4.3 ± 3.2 *(0.0 – 12.0)*	2.2 ± 2.7 *(0.0 – 11.0)*	1.9 ± 2.6 *(0.0 – 12.0)*
Eosin (% TWBC)	0.2 ± 0.6 *(0.0 – 4.0)*	0.3 ± 0.9 *(0.0 – 6.0)*	0.4 ± 0.8 *(0.0 – 5.0)*

Key: TWBC Total White Blood Cells Count; Neutr Neutrophils; Lymph Lymphocytes; Baso Basophils; Mono Monocytes; Eosin - Esoinophils

Majority of the babies had TWBC ranging from 8.0 to 13.9 × 10^9/L on the first day (49.4%), third day (58.4%) and in the sixth week (52.1%) as shown in Table 4. The proportion of babies with TWBC ranging from 3.5 to 7.9 × 10^9/L increased from 13.3% through 23.7% to 41.5% on the first day, third day and sixth week respectively. Similarly, the proportion of babies with TWBC ranging from 14.0 to 19.9 × 10^9/L decreased from 30.6% through 16.2% to 6.4% on the first day, third day and sixth week respectively.

Platelets

The platelets count ranged from 120 × 10^9/L to 649 × 10^9/L on the first day, 129 × 10^9/L to 607 × 10^9/L on the third day and from 124 × 10^9/L to 619 × 10^9/L in the sixth week. The mean values were 261.3 × 10^9/L, 242.5 × 10^9/L and 277.7 × 10^9/L on the first day, third day and sixth week respectively.
Most of the babies (90.6%, 94.8% and 88.0%) had platelets count varying between 150 × 10^9/L and 450 × 10^9/L on the first day, third day and sixth week respectively.

Table 4: Ranges of Platelet Counts on Days 1 and 3 and Week 6

Platelet count range (× 10^9/L)	Day 1	Day 3	Week 6
<149	10 (5.6)	3 (1.7)	7 (5.0)
150 – 299	122 (67.8)	129 (74.6)	79 (55.6)
300 – 449	39 (21.7)	34 (19.6)	54 (38.0)
450 - 599	7 (3.8)	6 (3.5)	1 (0.7)
>600	2 (1.1)	1 (0.6)	1 (0.7)
Total	180 (100)	173 (100)	142 (100)

Discussion

The mean PCV of 46.3 ± 7.2% reported on the first day of life in this study was similar to 45% and 46% previously reported values from Benin[5] and Lagos[12] respectively, both in the Southern part of Nigeria, but was lower than some other previously reported values of 49 to 51% in the Middle belt and Northern parts of Nigeria[4, 6] The differences do not appear to be purely due to regional factors as our mean value was higher than a figure of 42% previously obtained among Northern Nigerian neonates.[8] The mean PCV value obtained in the present study were similar to the mean values previously reported from other African countries (47% from Zimbabwe and 47% from Malawi).[13,14] The only study that recorded a mean PCV of 60.8 ± 7.2% at birth which was similar to theCaucasian values of 61.0 ± 7.4%, [1, 9, 15] was done at Ibadan, Nigeria[7] in 1976. The latter was done manually while the present study was done Electronically and this difference in methodology might be responsible for the difference in values obtained from both studies.

The lowest value of PCV obtained on the first day of life in the present study was 30%. Ordinarily, babies with PCV less than 40% on the first day of life would have been described as severely anaemic according to the Caucasian reference values being used presently.[9,15] Interestingly, none of these babies with PCV less than 40% on the first day of life had clinical features referable to severe anaemia such as lethargy, breathlessness or cardiac strain.

The mean PCV was highest on the first day in the present study and thereafter declined consistently through day-3 to week-6. This is consistent with findings in other Nigerian studies.[4-8, 12] The mean PCV values at the sixth week of life in this study were similar to values obtained from Northern Nigeria in 1984 at about the sixth week of life.[6] Caucasian infants also showed the same pattern of steady decline in the haemoglobin concentration.[1, 9, 15, 16]

There was relative reticulocytosis and high nucleated red blood cells count at birth and these showed a steady decline throughout the period of the study. This pattern was similar to that reported for neonates from other parts of Nigeria [4, 5, 6] Zimbabwe [13] and Malawi.[15] In healthy term newborns, virtually no nRBCs are found after the third or fourth day of life,[1,9] which was the pattern observed in this study. The measured red cell indices MCV, MCH and MCHC did not show significant differences between this study and previous studies [1, 4-7, 9, 13, 14]

The mean white blood cell count at birth in the present study was lower than those previously reported among babies in other parts of Africa, [4-6, 13, 14] and much lower than those for Caucasian newborns.[1, 9, 15]

Nevertheless, the mean value fell within the range of 3.5 × 10^9/L to 25.0 × 10^9/L as previously reported among other African and Caucasian babies.[4,6, 13-15] Although, bacteriologic screening was not routinely done for all the babies to exclude infections, particularly among the babies with extreme values, there was no report of any possible indicator of sepsis by the mothers or when the babies were examined. Neutrophils were the predominant white cells on the first day of life, but the proportion decreased gradually afterwards while the proportion of lymphocytes increased. By the sixth week of life, there was a reversal in the proportions of neutrophils and lymphocytes. The pattern of change between neutrophils and lymphocytes obtained in this study agrees with previous reports among Caucasian and African neonates, [1, 4, 9, 13] But differed from the finding in the Benin City study of 1984[6] in which a

Relatively higher proportion of lymphocytes was recorded at birth. With respect to other leucocytes, the concentrations of monocytes, eosinophils and basophils were similar to values cited for different ethnic groups in Nigeria overtime, [5, 6, 13, 14] and to those given in standard haematology textbooks for Caucasian newborns. [1, 9, 15] The reason for the disparity between the mean TWBC, neutrophil and eosinophil in African and Caucasian infant is not clear.

The mean platelet count on the first day of life (261.3 $\times 10^9 \pm 99.6 \times 10^9$/L) in the present study was

Essentially similar to many previous reports, [7, 13] but slightly higher than others from Jos[4] and Kaduna[6] in Northern Nigeria. The platelet count in this study has a wide range (120$\times 10^9$/L to 649 $\times 10^9$/L), which was the experience of previous researchers within and outside the country. [4, 6, 13, 14] Although, there was a marginal drop in the mean platelets count on the third day of life, this rose again by the sixth week of life, which is in agreement with the findings from Jos,[4] Nigeria. It is noteworthy that the values of platelet count obtained at the third day and sixth week of life in the present study were also similar to those of Caucasian neonates of same ages. [1, 9, 15] None of the infants studied had platelets count less than 100 x 10^9/L.

Conclusion

the values of most of the haematological parameters studied were highest on the first day of life and thereafter declined over the third day and the sixth week of life. Although, their mean values were not remarkably different from values previously obtained in Nigeria, they were lower than known Caucasian values. Further large scale multi-centre studies are required to generate data that could be used to evaluate and possibly redefine important conditions like severe anaemia, polycythaemia, leucocytosis, leucopaenia and thrombocytopaenia among Nigerian babies

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