SEED Haematology

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The use of absolute figures in haematology

The differentation of cellular components of white blood cells (differential blood count) is one of the most commonly applied laboratory methods. Since its introduction, however, manual differentiation has been subject to comparatively little changes over the years. A differential blood count should be performed to accurately assess an increased or reduced white blood cell (WBC) count. It should likewise be performed in order to establish which WBC sub-population is increased or reduced, or to determine if there are pathological cells in the peripheral blood (e.g. blast cells).

Automated differentiation of a blood count always reports the absolute concentration (e.g. 1,800 segmented neutrophils/µL) as well as the relative values (e.g. 45% segmented neutrophils). The absolute concentration of the WBC sub-population is essential for clinical interpretation, and should always be included in the laboratory findings. This is also in line with the official recommendations issued by the ICSH (International Council for Standardization in Haematology). If manual differentiation is carried out, the laboratory can also conveniently convert the percentage value into absolute figures using the laboratory IT, or a Work Area Management System (such as Sysmex SIS).

Why is an absolute value preferable to a percentage?

An increased cell sub-population does not mean that the overall WBC count also has to be increased. In the following, we would like to present some examples to illustrate significant differences in the interpretation of results in their use expressed as an absolute value and as a percentage value. The use of absolute figures is recommended, as they provide more precise diagnostic information. Lymphocytes are the exception, where both values, absolute and relative (%), should always be given.

1. Following cytotoxic chemotherapy a patient has a total WBC count of 2,000 cells/µL, of which 45% are lymphocytes, 25% monocytes and 30% segmented neutrophils. Looking at the absolute values, the monocyte count in this patient is normal at 500 cells/µL. The monocyte percentage, however, incorrectly suggests monocytosis. On the other hand, the patient only has 600 cells/µL neutrophils and thus a marked neutropenia, while the neutrophils expressed as a percentage do not point to this.

2. In a patient with chronic myeloid leukaemia, the increase in basophil concentration is an important diagnostic criterion. A percentage value of 1% basophils with a total WBC count of 100,000 cells/µL may appear to be normal, but when considering the absolute value, this shows pathological basophilia with 1,000 cells/µL.

3. A frequently occurring misinterpretation is lymphopenia in cases of an actual stress-induced leucocytosis (due to release of the neutrophil pool) following surgery in intensive-care patients. A patient with a WBC count of 20,000 cells/µL with stress-induced neutrophilia of 89%, 5% monocytes and only 6% lymphocytes does not actually have lymphopenia, as an absolute value of 1,200 cells/µL is within the normal lymphocyte range.

All cases of leukocytosis may be either reactive or neoplastic. In the latter case, the term ‘leukosis’ is preferred. All cases of leukopenia arise from either inadequate production or an accelerated breakdown of WBC. Note that only the absolute cell counts are of practical significance and not the percentage figure.

Neutrophilia, Neutropenia or actually normal?			
WBC total	Neutrophil percentage	Neutrophil absolute count	Assessment according to absolute neutrophil counts
1.8 x 10^3/µL	50%	0.6 x 10^3/µL	Neutropenia
2.6 x 10^3/µL	80%	2.1 x 10^3/µL	Normal
16.4 x 10^3/µL	50%	8.2 x 10^3/µL	Neutrophilia
48.6 x 10^3/µL	20%	9.7 x 10^3/µL	Neutrophilia

Exception: Lymphocytes

For lymphocytes, however, both the percentage and the absolute concentration are significant. A lymphocyte percentage of >50% in adults in the presence of a normal absolute total lymphocyte concentration may indicate that a sub-population is actually increased (e.g. T-helper cells, CD4). Lymphocytes measured either microscopically or automatically using routine haematology analysers cannot truly be separated into their individual sub-populations for T-, B- or O-lymphocytes – or can only be separated to a certain extent*. Consequently, in cases with a normal absolute value for the overall lymphocyte population, an increase in the overall lymphocyte percentage is an important addition to the haematological observations.

* *The XE-5000 differentiates activated antibody forming B-lymphocytes (HFLC). This value is available as a research parameter.*

Age dependent reference ranges for the absolute white blood count								
	WBC 10^9/L	NEUT 10^9/L	Seg NEUT 10^9/L	STAB 10^9/L	LYMPH 10^9/L	MONO 10^9/L	EO 10^9/L	BASO 10^9/L
Umbilical cord blood		2.1 – 19.1			1.3 – 10.7	0.10 – 3.50	0.05 – 1.80	
Newborn								
0 – 12 h	9.9 – 26.4	3.9 – 20.5	3.5 – 17.8	0.50 – 4.50	1.8 – 9.8	0.20 – 2.70	0.03 –1.10	0.00 – 0.35
12 – 24 h	9.9 – 28.2	4.5 – 22.3	3.8 – 18.5	0.60 – 4.70	1.8 – 9.8	0.20 – 2.70	0.03 –1.10	0.00 – 0.35
1 – 3 d	9.0 – 24.3	3.3 – 15.5	2.3 – 12.5	0.40 – 3.10	1.8 – 11.2	0.20 – 2.50	0.03 –1.00	0.00 – 0.30
3 – 7 d	8.1 – 21.6	2.1 – 10.7	1.3 – 8.5	0.20 – 2.50	2.0 – 12.6	0.20 – 2.50	0.04 –1.00	0.00 – 0.25
7 – 14 d	8.1 – 20.4	1.5 – 8.9	0.9 – 6.5	0.10 – 1.90	2.2 – 13.6	0.20 – 2.50	0.05 –1.00	0.00 – 0.25
14 – 30 d	7.2 – 19.2	1.3 – 8.3	0.9 – 6.5	0.10 – 1.90	2.2 – 13.6	0.20 – 2.30	0.05 –0.95	0.00 – 0.20
Infants								
1 – 3 m	6.6 – 16.2	1.3 – 7.9	1.1 – 6.2	0.10 – 1.30	2.7 – 12.6	0.25 – 1.90	0.05 – 0.90	0.00 – 0.20
3 – 6 m	6.6 – 15.6	1.3 – 8.3	1.1 – 6.8	0.10 – 1.30	3.0 – 12.2	0.25 – 1.70	0.05 – 0.85	0.00 – 0.20
6 – 12 m	6.6 – 15.6	1.5 – 8.7	1.3 – 7.4	0.05 – 1.20	3.2 – 11.2	0.20 – 1.45	0.05 – 0.80	0.00 – 0.20
Children								
1 – 2 a	6.0 – 15.0	1.5 – 8.7	1.3 – 8.0	0.05 – 1.20	3.0 – 10.0	0.15 – 1.20	0.03 – 0.70	0.00 – 0.20
2 – 4 a	5.4 – 13.8	1.5 – 8.5	1.5 – 8.0	0.05 – 1.20	2.2 – 8.5	0.10 – 1.10	0.02 – 0.75	0.00 – 0.20
4 – 6 a	5.1 – 12.9	1.7 – 8.5	1.6 – 7.8	0.05 – 1.20	1.8 – 7.0	0.10 – 1.00	0.02 – 0.75	0.00 – 0.20
6 – 12 a	4.8 – 12.0	1.7 – 8.1	1.7 – 7.4	0.00 – 1.10	1.5 – 6.0	0.10 – 0.95	0.02 – 0.70	0.00 – 0.20
Adolescents								
12 – 15 a	4.5 – 11.4	1.7 – 7.9	1.8 – 7.3	0.00 – 1.10	1.2 – 5.0	0.10 – 0.95	0.02 – 0.65	0.00 – 0.20
15 – 18 a	4.2 – 10.8	1.7 – 7.9	1.8 – 7.3	0.00 – 1.10	1.2 – 5.0	0.10 – 0.90	0.02 – 0.55	0.00 – 0.20
Adults								
18 – 65 a	3.9 – 10.2	1.5 – 7.7	1.7 – 7.2	0.00 – 1.10	1.1 – 4.5	0.10 – 0.90	0.02 – 0.50	0.00 – 0.20
>65 a	3.6 – 10.5	1.5 – 7.7	1.7 – 7.2	0.00 – 1.10	1.1 – 4.0	0.10 – 0.90	0.02 – 0.50	0.00 – 0.20

Tab. 2 *Herklotz et al.: Age-dependent reference ranges for the white blood count*

Reticulocytes

Due to the traditional method being recorded in % or ‰, it is likewise very common to only report relative values for reticulocytes. However, a reticulocyte count expressed as a percentage of the red blood cells (RBC) does not accurately reflect the absolute reticulocyte count. In order to assess the effectiveness of the bone marrow, it is important to take into account if the reticulocyte percentage is the result of the absolute increase in reticulocytes in the circulating blood, or the

result of the lower relative proportion of mature erythrocytes in the blood. In cases of anaemia, assessment therefore requires either a haematocrit-dependent correction (Heilmeyer) or an automatically counted, absolute measurement.

Table 4 shows an example of how the percentage reticulocyte value (3.5 %) can be misinterpreted as reticulocytosis when the absolute figure is actually normal at 73,000/µL. With the automatic measurement of the reticulocyte concentration (using fluorescence flow cytometry method of Sysmex X-Class analysers) an absolute reticulocyte value is given alongside the % or ‰ value. The result is additionally differentiated into various levels of maturity. The absolute reticulocyte value reflects bone marrow activity more accurately than the percentage value, as the absolute value shows the cell count per µL of blood, rather than per 1,000 RBC. The relative value depends heavily on the RBC count, which means that the diagnostic conclusion can be distorted.

Age-related reference ranges of reticulocytes and platelets			
	Reticulocytes 10^9/L	Reticulocytes %	Platelets 10^9/L
Newborn			
0 – 2 d	75 – 260	2.0 – 6.0	220 – 490
2 – 4 d	55 – 200	1.6 – 4.6	220 – 490
4 – 7 d	35 – 140	1.0 – 3.2	220 – 490
7 – 30 d	35 – 130	0.6 – 2.4	230 – 520
Infants			
30 – 45 d	25 – 105	0.7 – 3.2	240 – 550
45 – 60 d	30 – 130	0.7 – 3.2	240 – 550
2 – 3 m	30 – 130	0.7 – 3.0	240 – 550
3 – 6 m	30 – 120	0.7 – 2.7	240 – 550
6 – 12 m	25 – 110	0.6 – 2.4	240 – 520
Children			
1 – 2 a	25 – 100	0.5 – 2.2	220 – 490
2 – 4 a	25 – 95	0.5 – 2.2	200 – 460
4 – 6 a	30 – 100	0.5 – 2.2	200 – 445
6 – 12 a	30 – 105	0.5 – 2.2	180 – 415
Adolescents			
12 – 15 a	30 – 105	0.5 – 2.1	170 – 400
15 – 18 a	30 – 105	0.5 – 2.1	160 – 385
Adults			
18 – 65 a	25 – 105	0.5 – 2.0	150 – 370
›65 a	25 – 105	0.5 – 2.0	160 – 370

Tab. 3 *Herklotz et al: Age-dependent reference ranges for reticulocytes and platelets*

Suspected Reticulosis		
HGB	7.3	g/dL
WBC	5	x 10 ^{3}/µL
PLT	312	x 10^9/L
RBC	2.1	x 10^6/µL
MCH	35	pg
MCV	101	fl
MCHC	35	g/dL
HCT	21	%
RET#	73	x10^9/L
RET%	3.5	%

Tab. 4 *Example of an ineffective erythropoesis*

References

[1] Jones AR. *(1995): Absolute versus proportional differntial leucocyte count. Clin Lab Haematol 17 (2) : 115 – 123.*
[2] Heimpel H.: *'Hämatologie in der Praxis', Gustav Fischer Verlag, 2nd edition – German*
[3] Herklotz R et al. *(2006): Reference ranges in haematology. Therapeutische Umschau 63 : 5 – 24.*

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