RDW-SD and RDW-CV: using this information practically

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The erythrocyte count is still a routine parameter in haematology and increases or decreases can provide valuable hints for diagnosis. However, not only the erythrocyte count itself is important. In combination with the haematocrit, haemoglobin concentration and the erythrocyte indices, it can provide information about the type of disease present. Not only the simple figures are important, but also the morphology of the cells. For example, the indices and the distribution width of the erythrocytes are used in the morphological classification of anaemia.

Erythrocyte morphology is traditionally examined under the microscope. The smear is first checked by eye to confirm that it is completely and optimally stained and evenly spread over 2/3 of the slide. The quality of the stain is then evaluated under weak magnification. A suitable range is then selected for differentiation. All three cell classes are then examined under strong magnification. The following criteria are important for erythrocytes:

- Size (comparison with lymphocyte nuclei, relationship to MCV)
- Deviations in shape
- Stain, haemoglobin content (comparison with the MCH)
- Inclusions
- Precursors

Major fluctuations in erythrocyte size are called anisocytosis. Anisocytosis is the most frequent erythrocyte anomaly, a non-specific change in all severe forms of anaemia, and no conclusion can be drawn about its origin. In addition, intense reticulocyte replication always gives rise to anisocytosis[1].

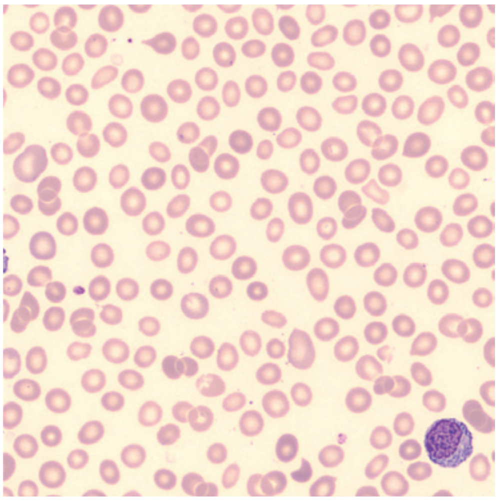

Fig. 1 *Anisocytosis in a smear under the microscope*

In every visual field in the microscope, erythrocytes can easily be seen which are microcytes and/or macrocytes and which make up 3% or more of all erythrocytes. In other words, there are more than 5 erythrocytes of unusual size in each visual field. An average of at least 5 visual fields must be determined. If the smear technique is correct, a visual field contains about 200 erythrocytes.

A semiquantitative measurement has become established for routine work. A distinction is made between isolated '(+)', several '+', many '++' and very many '+++' [1]. As in any semiquantitative measurement, the decision whether the result is '(+)', '+', or perhaps '+++' lies in the eye of the observer. There is little comparability between observers.

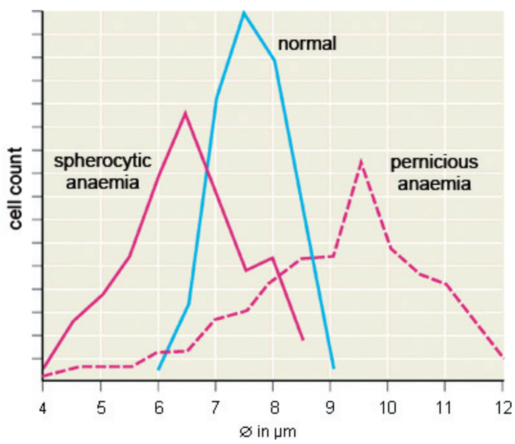

Fig. 2 *Price-Jones curve*

To permit an objective statement, a Price-Jones curve was set up some time ago. This was named after Cecil Price-Jones, the British pathologist. This in--volves measuring the diameter of the erythrocytes with an ocular micrometer and plotting the results as a distribution curve, with the x-axis as the size or the size class with 0.5 µm in breadth and the y-axis as the cell count. The shape of the curve may indicate the presence of different sorts of anaemia. The normal curve is a typical Gauss distribution. In pernicious anaemia, the base is widened and the maximum is displaced to the right. On the other hand, microcytosis gives displacement to the left. If the sample exhibits anisocytosis with major variations in size, the curve is broadened and flattened (Fig. 2). However, this method has never become established for routine work, as measuring each erythrocyte diameter is very tedious.

One of the most important reasons to automate haematological measurements is saving time. Moreover, the statistical error of the automated determination of the blood count parameters is much less, as the machine counts much higher cell numbers.

The erythrocytes are counted on Sysmex instruments, using the principle of impedance (resistance) measurements. The diluted cells are consecutively passed through a capillary opening. If a cell passes through the capillary opening, the voltage over the transducer is changed, giving an electrical signal which is proportional to the volume of the cell. All these impulses generated by the erythrocytes then form a volume distribution curve. In most instruments, this measurement principle is supported by hydrodynamic focussing. This almost completely excludes interfering factors, such as coincidences and recirculation, and the cells are counted with high precision.

The instruments supply not only the erythrocyte count, but also display the cell distribution as a histogram, as well as the erythrocyte indices and additional parameters, such as RDW-SD and RDW-CV, which allow additional morphological conclusions.

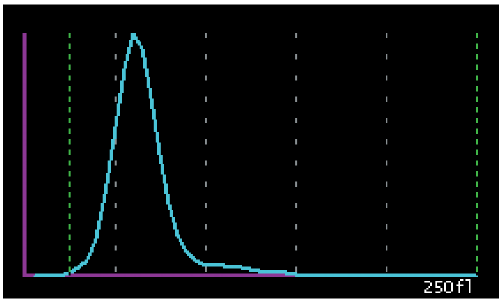

Fig. 3 *RBC histogram in the Sysmex X-Class browser setting*

Figure 3 shows an erythrocyte histogram. Erythrocytes can be recorded up to a volume of 250 fL. Normal erythrocytes have an average volume of 80 to 100 fL. The grey lines in the histogram can be used as an aid; these show volume differences in 50 fL steps. The histogram curves should always lie between the discriminators (green lines) and begin and end on the baselines (x-axis). With microcytic erythrocytes, the whole curve is displaced to the left. With large erythrocytes, the histogram curve is displaced to the right.

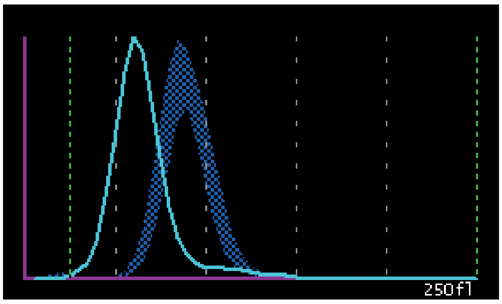

Fig. 4 *RBC histogram from the Sysmex X-Class browser setting with superimposed normogram*

In almost all analysers, it is possible to superimpose the normal distribution, so that the question 'Microcytic or macrocytic?' can be answered at a glance. Figure 4 shows the same RBC histogram as in the previous figure, but with the normal distribution superimposed (normogram = blue hatched background). There is a clear displacement to the left in this histogram. The erythrocytes are microcytic.

The parameters RDW-SD and RDW-CV are calculated from the histogram and are available for every measurement of the haemogram. This permits a statement on the erythrocyte distribution without having to examine a blood smear under the microscope. RDW stands for 'Red Cell Distribution Width'.

RDW-SD

The determination of the RDW-SD on Sysmex instruments is an actual measurement of the width of the erythrocyte distribution curve. This measurement is performed at a relative height of 20% above the baseline. The wider the curve is spread by erythrocytes of different sizes, the higher the RDW-SD value will be.

Reference values:[2]
female: 36.4–46.3 fL
male: 35.1–43.9 fL

RDW-CV

The RDW-CV is calculated from the formula:

$$\text{RDW-CV} = \frac{1SD}{MCV} \times 100$$

1SD reflects the size variation of the erythrocytes round the mean. As the 1SD is divided by the MCV, the RDW-CV also depends on the mean size (MCV) of the erythrocytes.

Reference values:[2]
female: 11.7–14.4%
male: 11.6–14.4%

The width of the erythrocyte distribution curve RDW reflects the variability in erythrocyte size and is thus a measure of anisocytosis. Erythrocyte indices are important in the classification of anaemia or for the early recognition of processes which can cause anaemia.

Determination of the MCV is used in the classification into normocytic, microcytic and macrocytic anaemia, which is important in diagnosis. In combination with the RDW, this is the best criterion for the classification of anaemias. As the MCV is an arithmetic mean, it does not exclude partial microcytosis – even in the reference range. Only in combination with the RDW, it may indicate dimorphic erythrocytes, for example, in the initial stages of iron deficiency.

Microcytic-Isocytic		Microcytic-Anisocytic		Normocytic-Isocytic		Normocytic-Anisocytic		Macrocytic-Isocytic		Macrocytic-Anisocytic	
MCV	RDW	MCV	RDW	MCV	RDW	MCV	RDW	MCV	RDW	MCV	RDW
de-creased	normal	de-creased	in-creased	normal	normal	normal	in-creased	in-creased	normal	in-creased	in-creased
β-Thalassaemia minor		Iron deficiency anaemia		Anaemia of chronic diseases		Osteomyelofibrosis		Aplastic anaemia		Pernicious anaemia	

Table 1 *Classification of anaemia on the basis of MCV and RDW values* [3]

Literature

[1] Handbuch zum Mikroskopierkurs Hämatologie 2001; R. Fuchs, J. Thomalla
[2] Sysmex Lab Info: 'Referenzwertbereiche für die Hämatologie: Sysmex X-family'; 03-2006
[3] L. Thomas: Labor und Diagnose; TH-Books; 6. Auflage 2005

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