Customer Information
Literature List – Red Blood Cells

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Note: Whether references are given in British or American English depends on the original. New entries are highlighted by this icon.

**General**


What we see as the essence: Indicated by the high correlation coefficient of 0.96 the InteRRliner showed an excellent comparability to the HumaSed ESR method.

**Tailor H et al.** (2017): Evaluation of the Sysmex XN-550, a Novel Compact Haematology analyser from the XN-L® series, compared to the XN-20 system. *Int J lab Hematol*; early online

What we see as the essence: Samples from adult patients (N=202) were measured on the XN-550 and compared with an XN-20. Good correlations and low bias was observed for all parameters except for BASO%. PLT-O from the XN-550 showed no significant bias compared to PLT-F from the XN-20.


What we see as the essence: The XN-550 showed a good analytical performance and strong correlation with XE-2100 and XN-3000 analysers for routine CBC parameters.

**Cao J et al.** (2017): Establishing a Stand-Alone Laboratory Dedicated to the Care of Patients With Ebola Virus Disease. *Lab Med*; 48(2): 188
[https://doi.org/10.1093/labmed/lmw072](https://doi.org/10.1093/labmed/lmw072)

What we see as the essence: The pocH-100i was used in a laboratory dedicated to detection of Ebola virus disease. Its accuracy was verified by comparison with the XE-2100 in the main laboratory, and its precision and reportable range were also consistent with Sysmex's claims.


What we see as the essence: The authors report the cutoff values for most of the RBC abnormalities that can be detected by the Advanced RBC Morphology software.
Tamigniau A et al. (2017): From XE-2100 to XN-9000, from SIS Standard to GFHC recommendations for slide review: potential impact on review rate and turnaround time. Annales de biologie Clinique. 75(3): 285
http://www.jle.com/fr/revues/abc/e-docs/from_xe_2100_to_xn_9000_from_sis_standard_to_gfhc_recommendations_for_slide_review_potential_impact_on_review_rate_and_turnaround_time_309721/article.phtml

What we see as the essence: Changing from the XE-2100 to XN-9000 and implementing the Biomedical Validation ruleset led to a significant reduction in review rate (from 35.8% to 25.9%) and TAT. In this hospital this resulted in a cost reduction of 7000 Euros over 6 months


What we see as the essence: The XP-300 showed very good precision and linearity results, comparable with the XN-3000 analyser.


What we see as the essence: Using the biomedical validation criteria, 21.3% of samples triggered a smear review. Modification of four criteria reduced the number of smears from 21.3% to 15.0% without loss of clinical value.


What we see as the essence: The use of the optical RBC parameters from the XN-Series can save time and help in the determination of the cause of increased MCHC.


What we see as the essence: The XN-Series and XN-L Series were compared; correlations were good and the study showed that the XN-L Series provided the same high quality as the XN-Series.

What we see as the essence: The authors report excellent detection of teardrop cells in samples from patients with myelofibrosis and MDS, using the Advanced RBC Morphology software.


What we see as the essence: Case report of severe haemolytic anaemia with cold agglutinins, identified by increased MCHC and qualitative alarms. The RBC-O and HGB-O parameters from the RET channel, and the RBC most frequent volume (R-MFV) allowed to report the correct results.


What we see as the essence: This paper gives a good overview of the technology behind the XE-Series and the benefits of flow cytometry and automatic cell counting. It shows that the XE-5000 delivers faster accurate results than older analysers.

**Genevieve F et al.** (2014): Smear microscopy revision: propositions by the GFHC. *feuilles de Biologie* VOL LVI N° 317  

What we see as the essence: The GFHC reviewed in detail the criteria used within the CBC to generate blood smears and has decided on a number of minimum recommendations, defining threshold values and various situations in which the blood smear review is desirable.

http://clinical-laboratory.de/article/1068

What we see as the essence: A combination of sample dilution and the use of RBC parameters from the RET channel on the XE-2100 is described to obtain accurate RBC parameters from samples with RBC cold agglutination without heating of the sample.

Article in French - Free online: http://www.jle.com/fr/revues/abc/e-docs/anomalies_et_erreurs_de_determination_de_lhemogramme_avec_les_automates_d_hematologie_cellulaire_partie_3_hemoglobine_hematies_indices_erythrocytaires_reticulocytes_292317/article.phtml

What we see as the essence: A summary report about potential interferences of CBC parameters with focus on situations leading to abnormal HGB, RBC and MCV, resulting in abnormal calculated RBC indices, e.g. MCHC. Alternative strategies may support management of interferences.

RET / IRF


What we see as the essence: Both IRF% and IPF% can be used to predict neutrophil and platelet recovery, respectively. Work was done on XE-5000.


What we see as the essence: In 52% of paediatric ALL patients, IRF% values rose before NEUT# values during recovery after chemotherapy. Therefore, monitoring of both parameters may be beneficial.

http://www.transplantation-proceedings.org/article/S0041-1345(10)01945-7/abstract

What we see as the essence: The immaturity fractions IRF and IPF offer an easy and early evaluation method of posttransplantational recovery of the bone marrow.


What we see as the essence: Reticulocyte maturation parameters (measured here on ABX Pentra) can support differential diagnosis of macrocytic anaemias.
RET-Hₑ / RBC-Hₑ

Free online: http://www.actamedindones.org/index.php/ijim/article/view/316/pdf
What we see as the essence: A very strong correlation (r=0.91) and a good concordance was found between RET- Hₑ and CHr with a mean bias of 0.5 pg in chronic kidney disease patients undergoing haemodialysis. It indicates that RET- Hₑ and CHr can both be used for assessing iron status.

http://rd.springer.com/article/10.1007/s12185-017-2212-6
What we see as the essence: RET- Hₑ was shown to be a clinically useful marker for determining iron deficiency in the general population and can also be used for the evaluation of the efficacy of iron administration.

What we see as the essence: RET- Hₑ and %Hypo- Hₑ, measured on the XE-5000, allowed identification of patients with iron deficiency, especially those who had already developed anaemia. RET-He had a better sensitivity, presumably because it is more responsive to iron deficiency.

Weimann A et al. (2016): Delta-He, Ret-He and a New Diagnostic Plot for Differential Diagnosis and Therapy Monitoring of Patients Suffering from Various Disease-Specific Types of Anemia. Clin Lab; 62(4):667
http://clinical-laboratory.de/article/1982
What we see as the essence: A diagnostic plot using RET-Hₑ and Delta-Hₑ was developed based on differences between different patient groups suffering from anaemia. Several case examples show the clinical utility of this plot for therapy monitoring.

Free online: http://japi.org/november_2016/pdf/06_oa_Reticulocyte.pdf
What we see as the essence: This study showed that RET-Hₑ is a better predictor of bone marrow iron stores in patients with severe anaemia than serum ferritin.

What we see as the essence: HYPO-Hₑ and RET-Hₑ are reliable parameters for the study of erythropoiesis status in hemodialysis patients.

**Al-Ghananim RT et al.** (2016): Reticulocyte Hemoglobin Content During the First Month of Life in Critically Ill Very Low Birth Weight Neonates Differs From Term Infants, Children, and Adults. *J Clin Lab Anal.* 30(4):326  

What we see as the essence: "RET-Hₑ values from the XE-2100 were lower in very low birth weight infants than in term infants, children and adults. RET-Hₑ was 31.8 pg within 24 hr after birth and subsequently declined to a steady-state level of 28.4 pg."

http://www.tandfonline.com/doi/pdf/10.3109/10408363.2015.1038744

What we see as the essence: This review gives an overview of the haematological, biochemical and genetic markers for identifying iron deficiency. RBC-Hₑ, RET-Hₑ, Delta-Hₑ, HYPO-Hₑ and MicroR are mentioned besides the standard RBC indices.

http://ajcp.ascpjournals.org/content/142/4/506.long

What we see as the essence: RET-Hₑ values above 31 or 32 pg could be used to rule out iron deficiency in cancer patients. In the present study the use of RET-Hₑ would have reduced the number of biochemical iron studies by 66% (from 209 to 70).

Free online: http://www.pagepress.org/journals/index.php/hr/article/view/hr.2012.e24

What we see as the essence: Ret-Hₑ and Ret-Hₑ/RBC-Hₑ ratio are sensitive markers for screening when a decrease in red blood cell haemoglobin content is observed and for monitoring short-term effects of iron supplementation. The authors recommend integrating these parameters into the protocol for anaemia screening and monitoring during pregnancy.


What we see as the essence: In patients with community-acquired pneumonia, acute inflammation results in decreased RET-Hₑ values at an early stage, reflecting acute erythropoietic dysfunction.

What we see as the essence: RET-Hₑ and %HYPO-Hₑ are helpful in assessing erythropoiesis and iron status.


What we see as the essence: A special algorithm combining RBC-Hₑ, RET-Hₑ and lactate dehydrogenase bears the potential as a marker of haemolysis strongly correlated with albuminuria in sickle cell anaemia patients.

http://www.karger.com/Article/FullText/313785

What we see as the essence: Due to fluctuations of iron status parameters, a fixed time point should be used for iron status monitoring during erythropoietin therapy.


What we see as the essence: The Thomas-plot is helpful in diagnosing patients referred from general practitioners and differentiating functional iron deficiency from classical iron deficiency.


What we see as the essence: RET-Hₑ is a useful sensitive and early indicator of iron status in the second half of pregnancy and should ideally be measured in combination with zinc protoporphyrin (ZPP) and IRF.

http://www.ajkd.org/article/S0272-6386(10)00918-2/abstract

What we see as the essence: RET-Hₑ could prove superior to transferrin saturation (TSAT) and ferritin in monitoring iron status of haemodialysis patients due to a lower biological variation.

http://informahealthcare.com/doi/abs/10.1080/00365510802657673

What we see as the essence: RET-Hₑ and CHr correlate and agree well in evaluating CKD patients needing iron support.

What we see as the essence: RET-Hₑ is equivalent to CHr and useful in managing haemodialysis patients with iron deficiency as it responds more rapidly than HGB.


What we see as the essence: Reticulocyte haemoglobin can be used to differentiate iron deficiency from other causes of anaemia and as an early marker to monitor the therapy.


What we see as the essence: The Thomas-plot incl. RET-Hₑ can be used for the differential diagnosis of anaemia and also gives therapy options.


What we see as the essence: RET-Hₑ is a reliable marker of cellular haemoglobin content and can be used to identify iron-deficient states, particularly in dialysis patients. RET-Hₑ and CHr are in good agreement.


What we see as the essence: Biochemical parameters reflecting functional iron availability and haematological parameters reflecting haemoglobinisation are interdependent.


What we see as the essence: RET-Hₑ can replace CHr in the diagnostic Thomas-plot without loss of sensitivity or specificity.

[Free online: http://www.haematologica.org/content/90/8/1133.long](http://www.haematologica.org/content/90/8/1133.long)

What we see as the essence: RET-Hₑ is useful for the differential diagnosis of iron deficiency anaemia vs anaemia of chronic disease and could also be helpful in the identification of thalassaemia patients.
Free online: http://ajcp.ascpjournals.org/content/121/4/489.long
What we see as the essence: RET-Y closely correlates with CHr and can be used for diagnosis and early monitoring after the administration of intravenous iron.

HYPO-Hₑ / HYPER-Hₑ / MicroR / MacroR

http://ajcp.ascpjournals.org/content/138/2/300.abstract
What we see as the essence: The authors conclude that the advanced algorithms, derived from extended RBC parameters provided by the Sysmex XE-5000 analyzer, are useful as laboratory devices for anaemia screening.

What we see as the essence: The hereditary spherocytosis diagnostic tool by Mullier et al. is useful and works, but needs fine-tuning to the local patient population.

What we see as the essence: Combining several RBC parameters allows to efficiently screen for hereditary spherocytosis even in mild cases.

Free online: http://ajcp.oxfordjournals.org/content/ajcpath/135/3/374.full.pdf
What we see as the essence: Because of high sensitivity and specificity, the new index %MicroR-%HYPO-Hₑ was the most reliable index in the differential diagnosis of microcytic anaemias.
What we see as the essence: Beta-thalassaemia can be recognised through high RBC, small MCV, high %MicroR and moderately increased IRF, whereas iron deficiency shows high RDW and %HYPO-He.

What we see as the essence: Because of high sensitivity and specificity, the new index %MicroR-%HYPO-He was the most reliable index in the differential diagnosis of microcytic anaemias.

What we see as the essence: The new parameters %HYPO-He/%HYPER-He and %MicroR/%MacroR appear to be sensitive for detecting small changes in the number of red cells with inadequate haemoglobinisation and volume in order to distinguish beta-thalassaemia from iron deficiency anaemia.

NRBC

Free online: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4695082/
What we see as the essence: "The presence of NRBC (XE-2100) was associated with a higher ICU mortality (49.4% vs 21.7%, P<0.001) as well as in-hospital mortality (61.4% vs 33.3%, p = 0.001).

Cremer M et al. (2015): Nucleated red blood cells as marker for an increased risk of unfavorable outcome and mortality in very low birth weight infants. Early Hum Dev.; 91(10):559-563
http://www.earlyhumandevelopment.com/article/S0378-3782(15)00123-1/abstract
What we see as the essence: This study of 438 low birth weight infants indicates that an NRBC count obtained 24-120 h after birth can serve as a surrogate marker for later severe morbidity and mortality. The optimal cut-off value was 2x10^9/L with 83% sensitivity and 75% specificity.

What we see as the essence: NRBC counts from the XN-Series could replace manual counts: the precision of the XN-Series was superior and a small bias (manual counts slightly higher than NRBC counts from the XN-Series) was only observed for NRBC counts above 200/100 WBC.


What we see as the essence: Repeatability, linearity and carryover was good for all tested analysers, and correlation between the analysers was good for HGB, MCV, PLT and WBC.

Quotes: "The XN showed a higher sensitivity than the SAPH and DxH for all flags of interest." "For the first time, we have decreased the slide review for our laboratory from 20% with the SAPH to 9.3% with the XN."


What we see as the essence: An excellent correlation was found between manual NRBC counts and NRBC counts from the XE-2100 ($r^2 = 0.94$) in umbilical cord blood. This number may be used to correct the WBC count and thereby guarantee an adequate WBC concentration for blood banking of umbilical cord blood.


What we see as the essence: An increased count of nucleated red blood cells in preterm newborns born from pregnancies with severe preeclampsia seems to be the first significant marker for detecting adverse neonatal outcome.


What we see as the essence: The results show excellent analytical performances for the XE-5000, with high accuracy and precision. In agreement with previous studies, the authors also showed that despite similar performance in terms of analytical imprecision, the overall correlation with microscopy is higher for XE-5000 than for ADVIA 2120, i.e., correlation coefficient 0.97 vs. 0.67 and AUC 0.97 vs. 0.73, respectively.
What we see as the essence: The NRBC count is an independent risk indicator of poor prognosis and mortality, NRBC-positive patients required a longer stay in the intensive care unit.

What we see as the essence: NRBC are found in nearly all onco-haematological diseases at diagnosis and frequently during therapy. They are absent at remission.

What we see as the essence: The NRBC count helps defining ineffective erythropoiesis in thalassaemia patients and supporting transfusion management.

Free online: http://ccforum.com/content/pdf/cc5932.pdf  
What we see as the essence: The NRBC count is one indicator of mortality — persistence (observed in daily screenings) and high concentration are both indicators for poor prognosis.

What we see as the essence: The NRBC count is one indicator of mortality independent of other factors such as kidney or liver failure.

What we see as the essence: NRBC count is an early indicator of mortality - daily screening is recommended.
What we see as the essence: Monitoring NRBC in stem cell transplantation patients provides useful clinical information - NRBC can be observed persistently in non-survivors.

What we see as the essence: The NRBC count is of high prognostic power regarding in-hospital mortality.

What we see as the essence: The NRBC count correlates well with flow cytometry.

http://www.journals.elsevierhealth.com/periodicals/ymlc/article/S0022-2143(02)00104-X/abstract
What we see as the essence: NRBC are often an only transient observation, but they indicate a poor prognosis, whether transient or persistent.

What we see as the essence: The automated NRBC count was highly correlated with the manual reference count ($r^2=0.97$) and thus eliminates the need for manual NRBC counts.

FRC

What we see as the essence: This performance evaluation showed that the CELLAVISION Advanced RBC Software Application is easy to use and provides a sensitive and reproducible measurement of schistocytes in peripheral blood.

What we see as the essence: Normal values were determined on the XN-Series for the percentage fragmented red blood cells, FRC%: 0.14 +/- 0.35% (mean 0%). It was also found that HYPO-He correlates with FRC%; so samples with both a high HYPO-He and FRC% should be interpreted with care.

Lesesve JF et al. (2012): Fragmented red blood cells automated measurement is a useful parameter to exclude schistocytes on the blood film. Int J Lab Hematol 34(6):566.  

What we see as the essence: The automated FRC count offers a better degree of certainty than microscopy to exclude the presence of fragmented RBC.

http://cat.sagepub.com/content/15/3/257.full.pdf

What we see as the essence: In conclusion, the FRC level is a simple and useful marker for thrombotic microangiopathy (TMA), and an FRC level of 1.2% is recommended as the cutoff value for the diagnosis of TMA.

http://europepmc.org/abstract/med/16024337

What we see as the essence: Sequential monitoring of FRC% may be a reliable marker for a specific type of complication (TTP-HUS; thrombotic thrombocytopenic purpura haemolytic uraemic syndrome) after allogeneic haematopoietic precursor cell transplantation.


What we see as the essence: The determination of FRC% by the XE-2100 enables early diagnoses and monitoring of TTP (thrombotic thrombocytopenic purpura) or TMA (thrombotic microangiopathy) and will be useful in the clinical field.


Initial study showing that the automated FRC% measurement is promising.