Literature List – White Blood Cells

Customer Information

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Note: Whether references are given in British or American English depends on the original.

NEW

New entries are highlighted by this icon.
General

Arbiol-Roca A et al. (2018)
Reference intervals for a complete blood count on an automated haematology analyser Sysmex XN in healthy adults from the southern metropolitan area of Barcelona.
EJIFCC; 29(1): 48
Free online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5949618/

What we see as the essence: The aim of the study was to establish reference intervals for CBC, DIFF and reticulocytes for a Spanish population. Significant gender differences were found for RBC, PLT, HCT and HGB.

Schapkaitz E et al. (2018)
Performance evaluation of the new measurement channels on the automated Sysmex XN-9000 hematology analyzer.
Clin Biochem; 53: 132

What we see as the essence: The XN showed very good analytical performance and workflow efficiency for a wide range of samples. Due to a WPC channel the authors observed a 34% reduction in the manual smear review rate.

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

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.

Jo SY et al. (2017)
Performance evaluation of recently launched Sysmex XN-550 Automatic Hematology Analyzer.
Int J Lab Hematol 39(1):e4

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.
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.

Van Dievoet MA et al. (2016)
Performance evaluation of the Sysmex® XP-300 in an oncology setting: evaluation and comparison of hematological parameters with the Sysmex® XN-3000
Int J Lab Hematol ; 38(5):490


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

Cornet E et al. (2016)
Evaluation and optimization of the extended information process unit (E-IPU) validation module integrating the sysmex flag systems and the recommendations of the French-speaking cellular hematology group (GFHC).


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.

Geara C et al. (2016)
Comparative study of quantitative performances between the new Sysmex XN-L (XN-550) haematology analyser and the XN-9000 in a routine laboratory.
Int J Lab Hematol 38(1):e10


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.
Seo JY et al. (2015)
Performance evaluation of the new hematology analyzer Sysmex XN-series.
Int J Lab Hematol.
37(2): 155

What we see as the essence: A good correlation was found between the XN- and XE-Series for all parameters. The XN-Series dramatically reduced the smear rate (by 58%). Even at counts below 500/µL the XN provided an accurate WBC count using the Low WBC mode.

Takagi Y et al. (2015)
Comparison of optical data from flow cytometry and microscopy of leukocytes after exposure to specific reagents.
Microscopy (Oxf) 64(5):305
http://jmicro.oxfordjournals.org/content/64/5/305.long

What we see as the essence: Flow cytometry software and electron microscopy methods were used to confirm the positions and fluorescence intensity of WBC populations in the XN-WDF scattergram.

Bruegel M et al. (2015)
Clin Chem Lab Med. 53(7): 1057

What we see as the essence: A comparison of Abbott, Beckman Coulter, Siemens and Sysmex analysers found superior flagging performance of the XN-2000, especially for blasts and variant lymphocytes. Otherwise, the analysers were comparable.

Tabe Y et al. (2015)
Performance evaluation of the digital cell imaging analyzer DI-60 integrated into the fully automated Sysmex XN hematology analyzer system.

What we see as the essence: This performance evaluation of the digital imaging analyser DI-60 showed a good agreement between results from the DI-60 and manual microscopy. In addition, blasts were correctly classified with 95% sensitivity and 99% specificity.
Genevieve F et al. (2014)
Smear microscopy revision: propositions by the GFHC.
feuillets de Biologie VOL LVI N° 317
Free online: http://www.gfhc.fr/upload/smear-microscopic-revision.pdf
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.

Nguyen VTP et al. (2013)
Immuno-analyse & Biologie Spécialisée 28: 125.
What we see as the essence: Compared with the Advia 2120i, the XN-2000 provided reliable, repeatable and stable results and increased the laboratory efficiency because of its speed and the reduced manual slide review rate. The BF mode allowed rapid and precise RBC and WBC counts.

Kawauchi S et al. (2013)
The Positions of Normal Leukocytes on the Scattergram of the Newly Developed Abnormal Cell-detection Channel of the XN-Series Multi-parameter Automated Hematology Analyzers.
Free online (after free registration): http://scientific.sysmex.co.jp/en/
What we see as the essence: Using purified leukocyte populations, the paper confirms the position of those populations within the WPC scattergrams. Interestingly, two populations of lymphocytes with a different resistance to WPC reagents were found.

Briggs C et al. (2012)
Performance evaluation of the Sysmex haematology XN modular system.
J Clin Pathol 65: 1024-30
http://jcp.bmj.com/content/65/11/1024.abstract Available from Sysmex upon request.
What we see as the essence: The XN showed reduced sample turnaround time and reduced number of blood film reviews compared to the XE-2100 without loss of sensitivity and with more precise and accurate results for both platelets and low WBC counts.
Flagging

**Dumas C et al. (2018)**
Automated Plasmodium detection by the Sysmex XN Hematology Analyzer.
J Clin Patho; early online

[http://jcp.bmj.com/content/early/2018/01/03/jclinpath-2017-204878.long](http://jcp.bmj.com/content/early/2018/01/03/jclinpath-2017-204878.long)

*What we see as the essence:* The study describes abnormal WDF scattergrams on the XN-Series for samples from patients infected with malaria. Most WDF scattergrams were not affected by Plasmodium falciparum infections but about 50% of non-falciparum infections caused scattergram abnormalities.

**Schuff-Werner P et al. (2016)**
Performance of the XN-2000 WPC channel-flagging to differentiate reactive and neoplastic leucocytosis.
Clin Chem Lab Med 54(9):1503


*What we see as the essence:* The XN-1000 demonstrated an excellent performance for differentiation between neoplastic and reactive leukocytosis.

**Jones AS et al. (2015)**
The value of the white precursor cell channel (WPC) on the Sysmex XN-1000 analyser in a specialist paediatric hospital.
J Clin Pathol 68:161

[http://jcp.bmj.com/content/early/2014/11/25/jclinpath-2014-202640](http://jcp.bmj.com/content/early/2014/11/25/jclinpath-2014-202640)

*What we see as the essence:* The flagging efficiency of the XE-5000 and XN-Series were compared in paediatric blood samples sensitivity was improved when only the WDF channel of the XN was used while both sensitivity and specificity were improved when also the WPC channel was used.

**Hotton J et al. (2013)**
Am J Clin Pathol 140: 845–852

[http://ajcp.ascpjournals.org/content/140/6/845.abstract](http://ajcp.ascpjournals.org/content/140/6/845.abstract)

*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."
Briggs CJ et al. (2011)
Improved Flagging Rates on the Sysmex XE-5000 Compared With the XE-2100 Reduce the Number of Manual Film Reviews and Increase Laboratory Productivity.

Free online: http://ajcp.ascpjournals.org/content/136/2/309.full.pdf+html

What we see as the essence: The increased specificity of the XE-5000 eMM (efficient multichannel messaging) flagging reduces the number of manual film reviews, particularly for blast and abnormal lymph flags.

Lymphocytes

Henriot I et al. (2017)
New parameters on the hematology analyzer XN-10 (SysmexTM) allow to distinguish childhood bacterial and viral infections.
Int J Lab Hematol 39(1):14

What we see as the essence: New parameters from the Sysmex XN allowed to differentiate between inflammation and infection in children. The parameter AS-LYMP (AUC=0.83) had the same discrimination power as procalcitonin (AUC=0.82) to distinguish between bacterial and viral infections.

Oehadian A et al. (2015)
New parameters available on Sysmex XE-5000 hematology analyzers contribute to differentiating dengue from leptospirosis and enteric fever.
Int J Lab Hematol 37(6):861

What we see as the essence: The detection of atypical lymphocytes, high-fluorescent lymphocytes and immature granulocytes on the XE-5000 supports the differentiation between common causes of febrile illnesses with thrombocytopenia in dengue areas.

Brisou G et al. (2015)
Alarms and Parameters Generated by Hematology Analyzer: New Tools to Predict and Quantify Circulating Sezary Cells.
J Clin Lab Anal 29(2): 153

What we see as the essence: Combining the ‘Blasts/Abn Lympho?’ flag with the Ly-X and Ly-Y parameters it was possible to differentiate Sezary patients from control patients (sensitivity 89%; specificity 98%) or from patients with chronic lymphoproliferative diseases (sensitivity 89%; specificity 94%). The proposed algorithm may alert themicroscopist that a sample likely contains Sezary cells.
**Van Mirre E et al. (2011)**
Sensitivity and specificity of the high fluorescent lymphocyte count-gate on the Sysmex XE-5000 hematology analyzer for detection of peripheral plasma cells.


**What we see as the essence:** The Sysmex XE-5000 is suitable for screening blood samples for the presence of elevated numbers of plasma cells in peripheral blood.

**Linssen J et al. (2007)**
Identification and quantification of high fluorescence-stained lymphocytes as antibody synthesizing/ secreting cells using the automated routine hematology analyzer XE-2100.
Cytometry B (Clin Cytometry) 72: 157–166.


**What we see as the essence:** The Sysmex high-fluorescence lymphocyte count quantifies activated B-lymphocytes with high precision and reliability in patients without haematological systemic diseases, thus providing a potential screening and monitoring tool for a suspected infection.

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**Monocytes**

**Buoro S et al. (2018)**
Evaluation and comparison of automated hematology analyzer flow cytometry, and digital morphology analyzer for monocyte counting
Int J Lab Hematol: 40(5): 577


**What we see as the essence:** Comparison of the XN-9000, CyFlow Space System and DI-60 compared with OM (optical microscopy) for the monocyte count revealed a better performance and higher values for flow cytometry than OM and DI-60 which have also a higher imprecision. The authors conclude also that the absolute monocyte count may be more reliable.

**Schillinger F et al. (2017)**
A new approach for diagnosing chronic myelomonocytic leukemia using structural parameters of Sysmex XN analyzers in routine laboratory practice.
Scand J Clin Lab Invest: 78(3): 159


**What we see as the essence:** A score derived from Sysmex XN parameters identifies possible CMML samples by excluding reactive monocytes. This reduces the smear review work load.
Kawauchi S et al. (2014)
Comparison of the Leukocyte differentiation Scattergrams Between the XN-Series and the XE-Series of Hematology Analyzers.
Int J Lab Hematol 24(1): 1

Free online (after free registration): http://scientific.sysmex.co.jp/en/

What we see as the essence: The paper explains the different effects of the WDF and DIFF reagents on leukocytes and why the WDF scattergram of the XN shows a better separation of the different cell populations, especially the separation between LYMPH and MONO is better.

Mazumdar R et al. (2013)
The automated monocyte count is independently predictive of overall survival from diagnosis in chronic lymphocytic leukaemia and of survival following first-line chemotherapy.
http://www.lrjournal.com/article/S0145-2126(13)00074-X/abstract

What we see as the essence: A monocyte count >0.91 \times 10^9/L at the time of diagnosis was associated with a shortened overall and treatment-free survival in CLL patients.

Granulocytes

Huang Y et al. (2019)
J Crit Care; 50: 303

What we see as the essence: Neutrophil fluorescence intensity (NEUT-RI) in blood samples of patients with septic shock was significantly higher in septic shock-induced disseminated intravascular coagulation (DIC) patients compared with non-DIC septic shock patients (70.0 vs. 50.7 FI).

Únal Y et al. (2018)
A new and early marker in the diagnosis of acute complicated appendicitis: immature granulocytes
Ulus Travma Acil Cerrahi Derg.; 24(5):434

What we see as the essence: IG# is a more reliable marker in predicting acute appendicitis than WBC, neutrophil lymphocyte ratio (NLR) and IG%, whereas IG% is more reliable in discriminating simple and complicated appendicitis.
Delabranche X et al. (2017)
Evidence of Netosis in Septic Shock-Induced Disseminated Intravascular Coagulation
J Crit Care; 47(3): 313
https://insights.ovid.com/pubmed?pmid=27488091

What we see as the essence: Neutrophil fluorescence intensity (NEUT-RI) in blood samples of patients with septic shock was significantly higher in septic shock-induced disseminated intravascular coagulation (DIC) patients compared with non-DIC septic shock patients (70.0 vs. 50.7 FI).

Ronez E et al. (2017)
Usefulness of thresholds for smear review of neutropenic samples analyzed with a Sysmex XN-10 analyzer.

What we see as the essence: A multi-center study showed that 1031 smear reviews triggered by isolated neutropenic samples (NEUT# < 1.5 G/L) resulted in the detection of only one positive sample (containing blasts). The authors recommend to use a lower cutoff of 1.0 G/L for smear review.

Hampson P et al. (2017)
Neutrophil Dysfunction, Immature Granulocytes, and Cell-free DNA are Early Biomarkers of Sepsis in Burn-injured Patients: A Prospective Observational Cohort Study.
Ann Surg.; 265(6):1241
https://insights.ovid.com/pubmed?pmid=27232244

What we see as the essence: Neutrophil and IG counts correlated with sepsis risk in burn patients. They could be used as predictive markers of sepsis in burn patients together with other markers such as the phagocytic index and cell free DNA.

Stiel L et al. (2016)
Neutrophil Fluorescence: A New Indicator of Cell Activation During Septic Shock-Induced Disseminated Intravascular Coagulation.
Crit Care Med; 44(11):e1132

What we see as the essence: Neutrophil fluorescence (NEUT-RI) above 57.3 FI had a sensitivity of 90.9% and a specificity of 80.6% for diagnosis of disseminated intravascular coagulation in patients with septic shock.
Park SH et al. (2015)
Sepsis affects most routine and cell population data (CPD) obtained using the Sysmex XN-2000 blood cell analyzer: neutrophil-related CPD NE-SFL and NE-WY provide useful information for detecting sepsis.
Int J Lab Hematol. 37(2):190

What we see as the essence: NE-SFL and NE-WY parameters have a good potential as sepsis markers and have a high specificity and sensitivity to differentiate between sepsis and non-sepsis groups.

Ha SO et al. (2015)
Fraction of immature granulocytes reflects severity but not mortality in sepsis.

What we see as the essence: Sepsis patients with an IG count on the XE-2100 of more than 0.5% were more likely to suffer from severe sepsis or septic shock, while WBC, CRP and PCT were not predictive of sepsis severity. None of the tested markers could predict 28-day mortality.

Cornet E et al. (2015)
Contribution of the new XN-1000 parameters NEUT-RI and NEUT-WY for managing patients with immature granulocytes.
Int J of Lab Hematol.: 37(5): e123

What we see as the essence: Normal values were determined on the XN-Series for the structural neutrophil parameters NEUT-GI, NEUT-RI and NEUT-WY. In addition, it was shown that NEUT-RI and NEUT-WY can be used to predict IG% values within a 72 h time frame.

Zimmermann M et al. (2015)
Detection and quantification of hypo- and hypergranulated neutrophils on the new Sysmex XN hematology analyzer: establishment of an adapted reference interval for the neutrophil-granularity-intensity compared to XE-technology in adult patients.
http://clinical-laboratory.de/article/1749

What we see as the essence: The reference intervals for NEUT-GI (XN-Series) and NEUT-X (XE-Series) were determined using 246 blood-healthy control patients: 140.91 - 160.46 channels and 129.20 - 142.33 channels, respectively. Neutrophil granularity was higher in ICU patients.
Arneth B et al. (2015)
Technology and New Fluorescence Flow Cytometry Parameters in Hematological Analyzers.
J Clin Lab Anal 29(3): 175


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.

Wiland EL et al. (2014)
Adult and child automated immature granulocyte norms are inappropriate for evaluating early-onset sepsis in newborns.
Acta Paediatr. 103(5): 494


What we see as the essence: A study on the XE-5000 showed that IG counts were increased during the first 2 days after birth. Therefore, the authors conclude that the use of adult and child norms for IG% is not appropriate for newborns when evaluating early-onset sepsis.

Nierhaus A et al. (2013)
Revisiting the white blood cell count: immature granulocytes count as a diagnostic marker to discriminate between SIRS and sepsis - a prospective, observational study.
BMC Immunology 14: 8

Free online: http://www.biomedcentral.com/content/pdf/1471-2172-14-8.pdf

Quote: Our findings demonstrate that sepsis is associated with an increased immature granulocyte count. The IG count can differentiate between patients with an infection and those who are not infected, particularly within the first critical hours after an initial SIRS alert. Using ROC analysis we found the IG count a superior biomarker for sepsis compared to C-reactive protein, lipopolysaccharide binding protein and interleukin-6.

Cimenti C et al. (2012)
The predictive value of immature granulocyte count and immature myeloid information in the diagnosis of neonatal sepsis.


What we see as the essence: Compared to a manual smear review, automated detection of IG # and IMI # represents a fast, accurate and less labour-intensive method and could improve screening and monitoring for early onset sepsis in neonates.
Roehrl MHA et al. (2011)
Age-dependent reference ranges for automated assessment of immature granulocytes and clinical significance in an outpatient setting.

Free online: http://www.archivesofpathology.org/doi/pdf/10.1043/2010-0258-OA.1

What we see as the essence: The use of appropriate reference ranges makes the IG count a powerful haematologic parameter for outpatient care that is associated with differential diagnoses that are distinctly characteristic of that setting.

Zimmermann M et al. (2011)
Granularity Index of the SYSMEX XE-5000 hematology analyzer as a replacement for manual microscopy of toxic granulation neutrophils in patients with inflammatory diseases.


What we see as the essence: The Granularity Index (GI) is suited to quantify the degree of toxic granulation of neutrophils. The GI is a parameter calculated from automated, standardised measurements. The authors suggest that it should replace the time-consuming and subjective microscopic procedure.

Le Roux G et al. (2010)
Routine diagnostic procedures of myelodysplastic syndromes: value of a structural blood cell parameter (NEUT-X) determined by the Sysmex XE-2100™.
Int J Lab Hematol 32: e237–243


What we see as the essence: NEUT-X and the calculated granularity index GI help to screen for myelodysplastic syndromes (MDS) with increased sensitivity without increasing unnecessary smears.

Furundarena J et al. (2009)
The utility of the Sysmex XE-2100 analyzer's NEUT-X and NEUT-Y parameters for detecting neutrophil dysplasia in myelodysplastic syndromes.


What we see as the essence: The parameters NEUT-X and NEUT-Y can be used to detect neutrophil dysplasia arising from MDS and chronic myelomonocytic leukaemia (CMML).
Linssen J et al. (2008)
Automation and validation of a rapid method to assess neutrophil and monocyte activation by routine fluorescence flow cytometry in vitro.

What we see as the essence: Fluorescence flow cytometry can measure activation steps of monocytes and polymorphonuclear neutrophils to defined external stimuli. This may potentially be applied as a screening and surveillance method for inflammatory diseases.

Fernandes B and Hamaguchi Y (2007)
Automated enumeration of immature granulocytes.
Am J Clin Pathol 128: 454
Free online: http://ajcp.ascpjournals.org/content/128/3/454.long

What we see as the essence: The results indicate that the automated IG count can replace the manual morphology count and is superior to it.

Ansari-Lari A et al. (2003)
Immature granulocyte measurement using the Sysmex XE-2100. Relationship to infection and sepsis.
Am J Clin Pathol 120: 795
Free online: http://ajcp.ascpjournals.org/content/120/5/795.full.pdf

What we see as the essence: The automated IG count matches the manual IG count very well. At significantly elevated levels, it is a very specific predictor of sepsis. Multiparameter algorithms might be more successful at lower concentrations.

Briggs C et al. (2000)
New quantitative parameters on a recently introduced automated blood cell counter – the XE 2100.

What we see as the essence: The IG count correlated with visual counts thus potentially improving screening and monitoring of various pathological conditions and reducing turnaround time.
Low WBC mode

Seo JY et al. (2015)
Performance evaluation of the new hematology analyzer Sysmex XN-series.
Int J Lab Hematol. 37(2): 155

What we see as the essence: A good correlation was found between the XN- and XE-Series for all parameters. The XN-Series dramatically reduced the smear rate (by 58%). Even at counts below 500/µL the XN provided an accurate WBC count using the Low WBC mode.

Tanaka Y et al. (2014)
Elimination of interference by lipids in the low WBC mode in the automated hematology analyzer XN-2000.
Int J Hematol. 36(4): e50

What we see as the essence: The study shows that potential interferences by the contamination of lipids have been eliminated in the two leukocyte channels of the XN-series, particularly compared to non-fluorescent methods. Furthermore, the new Low WBC mode showed better precision for leukopenic samples than the whole blood (WB) mode.

XN Stem Cells

Grommé M et al. (2017)
Multicenter study to evaluate a new enumeration method for hematopoietic stem cell collection management.
Transfusion: 57(8):1949

What we see as the essence: The XN Stem cell method correlates well with the gold standard of CD34 flow cytometry during stem cell mobilisation phase to determine apheresis start time, during apheresis for real-time monitoring and for QC of the final stem cell harvest.
Park SH et al. (2015)
free online http://www.annlabmed.org/journal/view.html?volume=35&number=1&spage=146

What we see as the essence: Stem cell counts from the XN-Series were more accurate than stem cell counts from the XE-Series when compared to CD34 flow cytometry.

Peerschke El et al. (2015)

What we see as the essence: XN-Stem Cells is a functional equivalent of CD34 analysis and may be a surrogate for CD34 analysis to predict optimal timing of stem cell collections from mobilized peripheral blood.

Tanosaki R et al. (2014)

What we see as the essence: This study found that CD34-positive cells fall in the XN stem cell gate in the WPC scattergram. The final yield of collected CD34-positive cells could be predicted from the XN-HPC value in pre-apheresis blood and apheresis products.