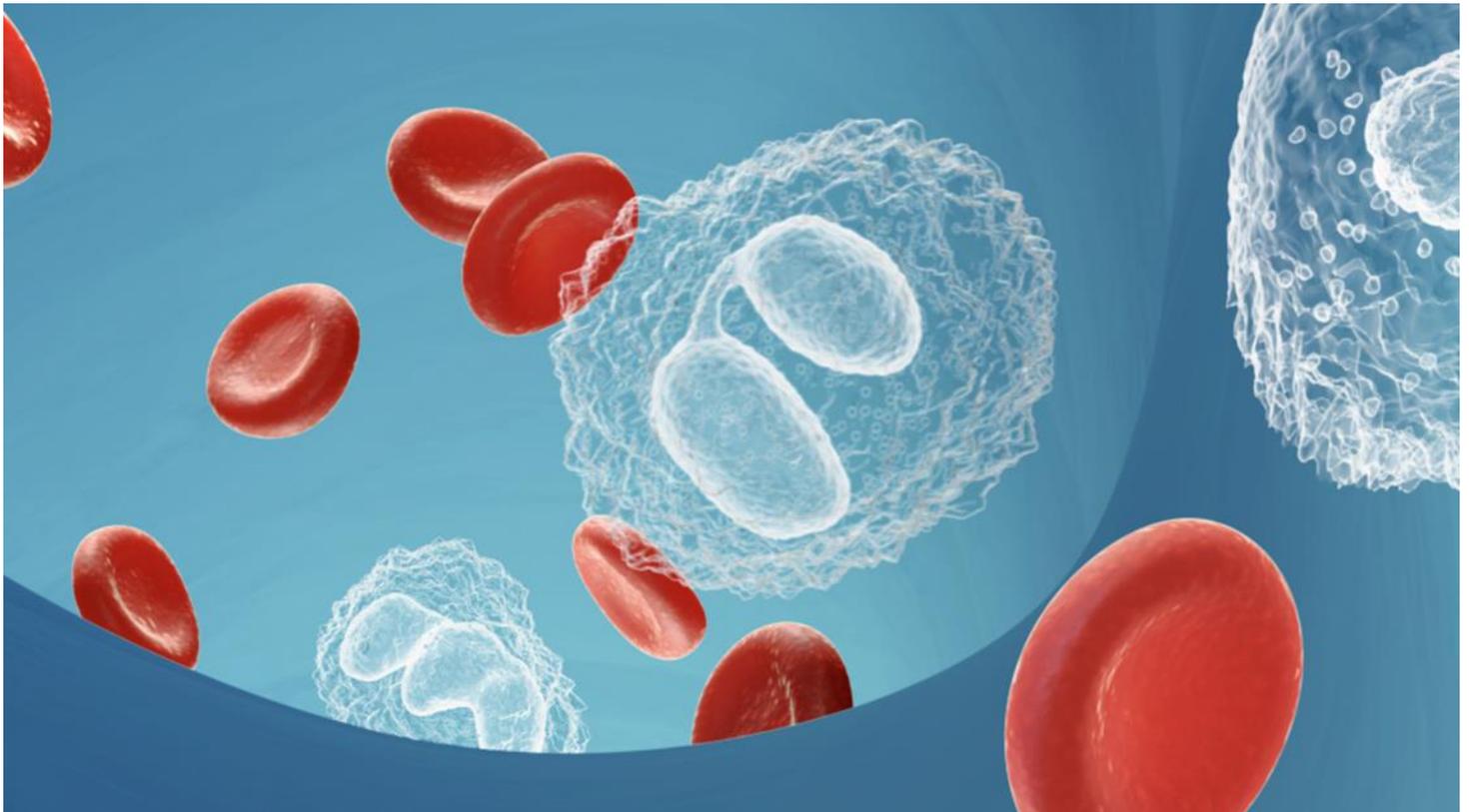


Literature List – White Blood Cells

Customer Information

November 2022



Date: November 2022
Subject: Literature List – White Blood Cells
Issued by: Scientific Customer Services
Number: 2022 – 03
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NEW

New entries are highlighted by this icon.

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The following list of research study publications is provided exclusively for scientific purposes.

- The studies may relate to the diagnostic use of the analytical parameters offered by Sysmex instruments. The diagnostic use is not validated by Sysmex and is therefore not in the scope of the Intended Purpose of the instruments. Details on the Intended Use can be found in the Sysmex Instructions For Use.
- Summaries of the study results are provided for convenience only and are not intended to convey any views of Sysmex on the study or the products used therein.
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- The information provided in the literature list is intended only for health care professionals.

Flagging

Dedenne L *et al.* (2022)

“Smart” WPC reflex testing enables optimal use of the WPC channel in the detection of malignant blood samples using Sysmex XN-9100.

Int J Lab Hematol; 44(4):e153

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13793>

Summary: In this follow-up publication of Blomme S *et al.* 2021, the authors have adjusted the criteria for WPC reflex testing. The revised workflow resulted overall in a 40% reduction in the number of WPC reflex tests and a 16% reduction in smear reviewing in a routine set-up.

Blomme S *et al.* (2021)

The integration of Sysmex XN-9100' WPC channel reflex testing in the detection of reactive versus malignant blood samples.

Int J Lab Hematol; 43(2): 191

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13352>

Summary: In this study the WPC reflex testing showed excellent sensitivity (99%), but low specificity (29%). Using reflex WPC to the WDF channel resulted in a 12% reduction of the smear review rate. The authors suggested workflow for the optimal use of the WPC channel in a routine setting.

Moioli V *et al.* (2020)

A specific abnormal scattergram of peripheral blood leukocytes suggestive for the presence of proerythroblast.

Scand J Clin Lab Invest; 80(1): 55

<https://www.tandfonline.com/doi/abs/10.1080/00365513.2019.1692230?journalCode=iclb20>

Summary: In this publication two cases of myeloproliferative disorder patients are described. Abnormal cell clusters in the WNR, WDF and WPC scattergrams were present. In oncological patients, this likely indicates the presence of proerythroblasts as a symptom of an erythroid leukaemia and therefore the XN scattergrams were suggested to support a rapid stratification.

Paridaens H et al. (2019)

Can the 72-hour rule based on "Blast/Abn Lymph" flag on Sysmex XN-10 optimize the workflow in hematology laboratory?

Ann Biol Clin (Paris); 77(4): 422

Free online: <https://www.jle.com/download/abc-315069-43157-can-the-72-hour-rule-based-on-blast-abn-lymph-flag-on-sysmex-xn-10-optimize-the-workflow-in-hematology-laboratory-a.pdf>

Summary: The authors verified GFHC rules for reducing unnecessary smears and even extended the rules for further smear reduction when using XN analysers. The very good sensitivity (93%) and specificity (94%) of the Blast/Abn Lympho? flag was confirmed in line with smear reduction of 5.7% and associated cost reduction.

Schuff-Werner P et al. (2016)

Performance of the XN-2000 WPC channel-flagging to differentiate reactive and neoplastic leukocytosis. Clin Chem Lab Med; 54(9): 1503

<https://www.degruyter.com/view/j/cclm.2016.54.issue-9/cclm-2015-1105/cclm-2015-1105.xml>

Summary: 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>

Summary: 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.

Ulset R J et al. (2014)

"Aged Sample" Software on Automated Routine Hematology Analyzer Enables Differentiation Between Pathological and Non-Pathological WBC Flagging in Aging Samples.

Clin Lab; 60(12): 1961

<https://www.clin-lab-publications.com/issue/108>

Summary: 'Aged Sample Identifier' software not only detects and labels samples that are ageing or were stored under suboptimal conditions, but also prevents false positive flagging.

Hotton J et al. (2013)

Performance and Abnormal Cell Flagging Comparisons of Three Automated Blood Cell Counters Cell-Dyn Sapphire, DxH-800, and XN-2000.

Am J Clin Pathol; 140: 845

<http://ajcp.ascpjournals.org/content/140/6/845.abstract>

Summary: 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.

Am J Clin Pathol; 136: 309

Free online: <https://academic.oup.com/ajcp/article/136/2/309/1766828>

Summary: 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

NEW

Tantanate C *et al.* (2018)

Performance Evaluation of High Fluorescence Lymphocyte Count: Comparability to Atypical Lymphocyte Count and Clinical Significance.

Lab Med; 49(4): 362

Free online: <https://academic.oup.com/labmed/article/49/4/362/5038976?login=true>

Summary: An analysis of 320 blood samples showed that the HLFC parameter from the XN-3000 was higher in samples with infection (n=229), and correlated well with the atypical lymphocytes from the microscopic examination (r=0.865 for counts, and r=0.893 for percentages). HLFC predicted the presence of atypical lymphocytes in the blood smear with an 80% sensitivity in this study.

Lesesve JF *et al.* (2022)

CAR-T Cells Microscopic and Phenotypic Identification in the Peripheral Blood.

Mediterr J Hematol Infect Dis; 14(1): e2022024

Free online: <https://www.mjhid.org/index.php/mjhid/article/view/4831>

Summary: The case study of a woman with large B-cell lymphoma treated with CAR-T cells highlights the value of close monitoring of treatment progress after CAR-T cell infusion with WDF channel. WDF scattergrams and peripheral blood smear found atypical lymphocytes that could represent the proliferating CAR-T cells.

Urrechaga E *et al.* (2021)

Leukocyte differential and reactive lymphocyte counts from Sysmex XN analyzer in the evaluation of SARS-CoV-2 infection.

Scand J Clin Lab Invest; 81(5): 394

Free online: <https://www.tandfonline.com/doi/abs/10.1080/00365513.2021.1929445?journalCode=iclb20>

Summary: The prospective observational study aimed to assess the diagnostic performance in distinguishing SARS-CoV-2 infections from other viral or bacterial infections in emergency room (ER) patients presenting with fever. NLR > 3.3 and RE-LYMP >0.6% correctly distinguished 95.6% of SARS-CoV-2 infection patients in the validation group (bacterial and viral infected ER patients).

Rutkowska E *et al.* (2021)

Usefulness of the New Hematological Parameter: Reactive Lymphocytes RE-LYMP with Flow Cytometry Markers of Inflammation in COVID-19.

Cells; 10(1): 82

Free online: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7825305/>

Summary: A study on patients with viral infections showed that RE-LYMP% correlated with the presence of plasmablasts (activated B cells). RE-LYMP also correlated with activation markers on CD4+ and CD8+ T cells in COVID-19 (CD8+ CD45RO+) or other infections (CD38+ and HLA-DR+).

Henriot I et al. (2017)

New parameters on the hematology analyzer XN-10 (Sysmex™) allow to distinguish childhood bacterial and viral infections.

Int J Lab Hematol; 39(1): 14

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12562/epdf>

Summary: The study investigated new parameters from the Sysmex XN in children with fever. The authors found that the parameter AS-LYMP was significantly higher in children with viral infections. The parameter AS-LYMP (AUC=0.83) had the same discrimination power as procalcitonin (AUC=0.82) to distinguish between bacterial and viral infections in this cohort.

Sale S et al. (2016)

Detection of Apoptotic Lymphocytes Through Sysmex XN-1000 As a Diagnostic Marker for Mononucleosis Syndrome.

J Clin Lab Anal; 30(5): 779

Free online: <https://onlinelibrary.wiley.com/doi/full/10.1002/jcla.21938>

Summary: The authors propose a new algorithm that integrates the 'Atypical Lympho?' flag, lymphocyte structural parameters (LY-WX, LY-WY, LY-WZ) and presence of events in area of the FCS-SSC and SFL-SSC scattergrams and could aid in the diagnosis of infectious mononucleosis.

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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12422/abstract>

Summary: This study investigated how 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 ClinLab Anal; 29(2): 153

<http://onlinelibrary.wiley.com/doi/10.1002/jcla.21744/abstract>

Summary: 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 the microscopist 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.

Clin Chem Lab Med; 49: 685

<http://www.degruyter.com/view/j/cclm.2011.49.issue-4/cclm.2011.100/cclm.2011.100.xml>

Summary: 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

Free online: <http://onlinelibrary.wiley.com/doi/10.1002/cyto.b.20150/pdf>

Reprinted in: Sysmex J Int 19(1): 19 <http://scientific.sysmex.co.jp/en>

Summary: This study demonstrates that 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.

Monocytes

Zhu J et al. (2019)

A hierarchical approach in the diagnostic workflow of chronic myelomonocytic leukemia: Pivotal role of the "Mono-dysplasia-score" combined with flow cytometric quantification of monocyte subsets.
Int J Lab Hematol; 41(6): 782

Free online: <https://onlinelibrary.wiley.com/doi/full/10.1111/ijlh.13115>

Summary: The authors set up a workflow for monocytosis samples including Mono-dysplasia score, smear review and flow cytometry. The proposed mono-dysplasia score was shown to be a valuable filter for reducing the number of smears without losing sensitivity for CMML suspicious samples.

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

<https://onlinelibrary.wiley.com/doi/abs/10.1111/ijlh.12868>

Summary: 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

<http://www.tandfonline.com/doi/full/10.1080/00365513.2018.1423702>

Summary: The study presents a score derived from Sysmex XN parameters that identifies possible CMML samples by excluding reactive monocytes. This reduces the smear review workload.

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.
Leukemia Research; 37(6): 614

[http://www.ljournal.com/article/S0145-2126\(13\)00074-X/abstract](http://www.ljournal.com/article/S0145-2126(13)00074-X/abstract)

Summary: 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 in this cohort.

Granulocytes

NEW

Cetin N *et al.* (2022)

Immature granulocytes as biomarkers of inflammation in children with predialysis chronic kidney disease
Pediatr Nephrol; online ahead of print

<https://link.springer.com/article/10.1007/s00467-022-05530-4>

Summary: A retrospective analysis in 57 children with predialysis chronic kidney disease (CKD) showed that IG%, IG#, WBC#, NEUT#, and NLR were higher compared to healthy children. IG parameters were also higher in stage 4 CDK compared to stage 2 and 3. IG% and IG# could predict the presence of inflammation with an AUC of 0.838 (sensitivity 74.2%) and 0.799 (sensitivity 70.8%) respectively in this cohort.

NEW

Lu Q *et al.* (2022)

Evaluation of immature granulocyte parameters in myeloid neoplasms assayed by Sysmex XN hematology analyzer
J Hemat; 15(1): 1

[Freeonline: https://link.springer.com/article/10.1007/s12308-022-00484-w](https://link.springer.com/article/10.1007/s12308-022-00484-w)

Summary: An analysis of 1,412 blood samples showed that IG% from an XN-Series analyser correlated well with manual microscopy in both myeloid neoplasms (n=388, r=0.83) and non-haematopoietic neoplasms (n=524, r=0.86). IG parameters correctly indicated the presence of immature granulocytes in myeloid neoplasm patients (sensitivity 75% for IG# and 81% for IG%).

Li S *et al.* (2022)

Neutrophil side fluorescence: a new indicator for predicting the severity of patients with bronchiectasis.
BMC Pulm Med; 22(1): 107

[Freeonline: https://bmcpulmed.biomedcentral.com/articles/10.1186/s12890-022-01893-4](https://bmcpulmed.biomedcentral.com/articles/10.1186/s12890-022-01893-4)

Summary: Unlike NEUT# and PCT, NEUT-SFL correlates significantly with Bronchiectasis Severity Index score in this study. The cut-off 42.15 FI for NEUT-SFL presents an AUC of 0.813 with a sensitivity of 67.1% and a specificity of 82.1%.

Lemkus L *et al.* (2022)

The utility of extended differential parameters as a biomarker of bacteremia at a tertiary academic hospital in persons with and without HIV infection in South Africa.

PLoS ONE; 17(2): e0262938

Freeonline: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0262938>

Summary: In a cohort of bacterial infection patients NE-SFL presented as the best extended differential parameter in identifying bacteraemia in HIV positive patients (AUC = 1) whilst in HIV negative patients IG% performed best (AUC = 0.79). The study revealed a significant correlation to neutrophil CD64 expression which adds scientific validity to NE-SFL as a marker for neutrophil activation.

Kim H *et al.* (2021)

Screening of myelodysplastic syndrome using cell population data obtained from an automatic hematology analyzer.

Int J Lab Hematol; 43(2): e54

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13361>

Summary: In a study of 63 patients with myelodysplastic syndrome (MDS), RBC, PLT, NE-FSC and NE-SSC exhibited the highest correlation with the disease (AUC from 0.87 to 0.94). The authors propose a combined interpretation of these four parameters for identifying MDS (one out of four cutoff criteria had to be fulfilled).

Stiel L *et al.* (2019)

First visualization of circulating neutrophil extracellular traps using cell fluorescence during human septic shock-induced disseminated intravascular coagulation.

Thromb Res; 183: 153

Free online: [https://www.thrombosisresearch.com/article/S0049-3848\(19\)30438-4/fulltext](https://www.thrombosisresearch.com/article/S0049-3848(19)30438-4/fulltext)

Summary: The authors reported direct visualisation of circulating neutrophils extracellular traps (NETs) in patients with septic shock induced disseminated intravascular coagulation (DIC). The previously reported in vivo relevance of NEUT-SFL in NETosis was confirmed.

Huang Y *et al.* (2019)

Immature granulocytes: A novel biomarker of acute respiratory distress syndrome in patients with acute pancreatitis.

J Crit Care; 50: 303

<https://www.sciencedirect.com/science/article/abs/pii/S0883944118313030?via%3Dihub>

Summary: In patients with acute pancreatitis, immature granulocytes (IG%) could facilitate the identification of patients with a high risk for developing acute respiratory distress syndrome (ARDS). The authors present IG% as a potential indicator of ARDS incidence with predictive power similar to (or greater than) other biomarkers.

Porizka M *et al.* (2019)

Immature granulocytes as a sepsis predictor in patients undergoing cardiac surgery.
Interact Cardiovasc Thorac Surg; 28(6): 845

<https://academic.oup.com/icvts/article/28/6/845/5299882>

Summary: Porizka *et al.* investigated the ability of IG, Procalcitonin (PCT), WBC, body temperature and combinations in a cohort of cardiac surgery patients for the ability to identify sepsis. IG and PCT exhibited an AUC of 0.71 and 0.72, whereas in combination AUC increased to 0.8. IG is presented as a valuable additional parameter to PCT that improves sepsis identification in this special patient cohort.

Ustyantseva M *et al.* (2019)

Innovative Technologies in the Evaluation of the Neutrophil Functional Activity in Sepsis.
Sysmex Journal International; 29(1): 8

Free online after free registration <http://scientific.sysmex.co.jp/en/>

Summary: The study revealed significantly higher values of neutrophil fluorescence intensity (NEUT-RI) in critically ill patients with sepsis (NEUT-RI = 70 FI) compared to the non-septic control group (NEUT-RI = 53 FI). Furthermore, strong correlations between the levels of NEUT-RI and generally recognized biomarkers of sepsis (PCT, CRP) were found.

Ünal 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

<http://tjtes.org/eng/jvi.aspx?un=UTD-91661>

Summary: WBC, neutrophil-to-lymphocyte ratio (NLR), IG# and IG% showed significant changes in patients with acute appendicitis compared to simple appendicitis, while changes in IG# were most prominent.

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>

Summary: In this study neutrophil fluorescence intensity (NEUT-RI) in blood samples of patients with septic shock exhibited significantly higher values in septic shock-induced disseminated intravascular coagulation (DIC) patients compared to 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.

Scand J Clin Lab Invest;77(6): 406

<http://www.tandfonline.com/doi/full/10.1080/00365513.2017.1334129>

Summary: 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 using 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>

Summary: Neutrophil and IG counts correlated with sepsis risk in burn patients. The authors propose the interpretation considering also 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

<http://journals.lww.com/ccmjournal/pages/articleviewer.aspx?year=2016&issue=11000&article=00039&type=abstract>

Summary: In this study neutrophil fluorescence (NEUT-RI) above 57.3 FI demonstrated a sensitivity of 90.9 % and a specificity of 80.6 % for 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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12261/abstract>

Summary: NE-SFL and NE-WY parameters showed significantly increased values in sepsis patients compared to the normal control group.

Ha SO *et al.* (2015)

Fraction of immature granulocytes reflects severity but not mortality in sepsis.
Scand J Clin Lab Invest; 75(1): 36

<http://www.tandfonline.com/doi/abs/10.3109/00365513.2014.965736?journalCode=iclb20#.VeRGSfJUC>
[Cp](#)

Summary: In this study cohort 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 did not correlate with sepsis severity.

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

<http://onlinelibrary.wiley.com/doi/10.1111/apa.12563/abstract>

Summary: 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 as supportive information in the diagnosis of 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.
Clin Chem Lab Med; 50: 1429

<http://www.degruyter.com/view/j/cclm.2012.50.issue-8/cclm-2011-0656/cclm-2011-0656.xml>

Summary: The study concludes that, automated detection of IG# and IMI# represents a fast, accurate and less labour-intensive method compared to a manual smear review and could improve screening and monitoring for early onset sepsis in neonates.

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.
Clin Chem Lab Med; 49: 1193

<http://www.degruyter.com/view/j/cclm.2011.49.issue-7/cclm.2011.188/cclm.2011.188.xml?format=INT>

Summary: The Granularity Index (GI) was shown to correlate well with 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

<https://onlinelibrary.wiley.com/doi/10.1111/j.1751-553X.2010.01247.x>

Summary: The authors present NEUT-X and the calculated granularity index GI as helpful in the screening for myelodysplastic syndromes (MDS) with increased sensitivity without increasing unnecessary smears.

Furundarena J et al. (2010)

The utility of the Sysmex XE-2100 analyzer's NEUT-X and NEUT-Y parameters for detecting neutrophil dysplasia in myelodysplastic syndromes.
Int J Lab Hematol; 32: 360

<http://onlinelibrary.wiley.com/doi/10.1111/j.1751-553X.2009.01194.x/abstract>

Summary: In this study the parameters NEUT-X and NEUT-Y were 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.
Cytometry B (Clin Cytometry); 74: 295

Free online: <http://onlinelibrary.wiley.com/doi/10.1002/cyto.b.20422/pdf>

Summary: In this study fluorescence flow cytometry was shown to 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 (2007)

Automated enumeration of immature granulocytes.
Am J Clin Pathol; 128: 454

Free online: <http://ajcp.ascpjournals.org/content/128/3/454.long>

Summary: 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>

Summary: In this study the automated IG count matched the manual IG count very well. At significantly elevated levels, it is was shown to be 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.
Clin Lab Haematol; 22: 345

<http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2257.2000.00330.x/abstract>

Summary: 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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12254/abstract>

Summary: 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/ μ L 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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12163/abstract>

Summary: 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

Reberšek K *et al.* (2021)

Hematopoietic progenitor cell counting can optimize peripheral blood stem cell apheresis process.
J Clin Apher; 36(6): 870

<https://onlinelibrary.wiley.com/doi/10.1002/jca.21941>

Summary: This study in autologous and allogeneic stem cell donors showed that HPC correlated well with CD34⁺ cell count, had a very good diagnostic accuracy to identify the apheresis starting point (AUC 0.852), and to predict both an insufficient (AUC 0.884) or sufficient (AUC 0.769) harvest.

Mishra S *et al.* (2020)

A study to compare Hematopoietic Progenitor Cell count determined on a next-generation automated cell counter with flow cytometric CD34 count in peripheral blood and the harvested peripheral blood stem cell graft from autologous and allogenic donors.

Int J Lab Hematol; 43(1): 76

Free online: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/ijlh.13341>

Summary: A study on allogeneic and autologous haematopoietic stem cell donors showed that HPC had a very good correlation with CD34⁺ count in peripheral blood and in the final harvest product, and was an efficient predictor for the optimal time of harvesting of stem cells.

Furundarena JR *et al.* (2020)

Evaluation of the predictive value of the hematopoietic progenitor cell count using an automated hematology analyzer for CD34⁺ stem cell mobilization and apheresis product yield.

Int J Lab Hematol; 42(2): 170

<https://onlinelibrary.wiley.com/doi/abs/10.1111/ijlh.13142>

Summary: The authors established two decision trees using XN haematopoietic progenitor cells count for decision making in autologous transplants. One for optimising the rational use of plerixafor in poor mobilisers and the second for decision on the optimal starting point of apheresis.

Dima F *et al.* (2020)

Assessment of haematopoietic progenitor cell counting with the Sysmex® XN-1000 to guide timing of apheresis of peripheral blood stem cells.

Blood Transfus; 18(1): 67

Free online: <https://www.bloodtransfusion.it/articolo.aspx?idart=003270&idriv=000148>;

Summary: The XN Stem Cell application was shown to assess the timing of apheresis and thus improve the apheresis workflow by reducing CD34 tests. The parameter demonstrates excellent diagnostic accuracy in different donor subsets, high precision and a very good correlation with CD34.

Grommé M *et al.* (2017)

Multicenter study to evaluate a new enumeration method for hematopoietic stem cell collection management.

Transfusion; 57(8): 1949

<http://onlinelibrary.wiley.com/doi/10.1111/trf.14183/full>

Summary: In this study the XN Stem Cell mode 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)

The New Sysmex XN-2000 Automated Blood Cell Analyzer More Accurately Measures the Absolute Number and the Proportion of Hematopoietic Stem and Progenitor Cells Than XE-2100 When Compared to Flow Cytometric Enumeration of CD34(+) Cells.

Ann Lab Med; 35(1): 146

[free online http://www.annlabmed.org/journal/view.html?volume=35&number=1&spage=146](http://www.annlabmed.org/journal/view.html?volume=35&number=1&spage=146)

Summary: 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 EI *et al.* (2015)

Evaluation of new automated hematopoietic progenitor cell analysis in the clinical management of peripheral blood stem cell collections.

Transfusion; 55(8): 2001

<http://onlinelibrary.wiley.com/doi/10.1111/trf.13078/abstract>

Summary: In this study XN-Stem Cells is presented as a functional equivalent of CD34 analysis and may be a surrogate for CD34 analysis to predict optimal timing of stem cell collections from mobilised peripheral blood.

Tanosaki R *et al.* (2014)

Novel and rapid enumeration method of peripheral blood stem cells using automated hematology analyzer.

Int J Lab Hematol; 36(5): 521

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12182/abstract>

Summary: This study found that CD34-positive cells fall in the area where stem cells locate 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.

General

NEW

Urrechaga E *et al.* (2018)

Role of leucocytes cell population data in the early detection of sepsis.
J Clin Pathol; 71(3): 259

<https://jcp.bmj.com/content/71/3/259>

Summary: Cell population data (CPD) were different between control and sepsis patients in both study (n=719) and validation (n=272) groups. The authors calculated the NEMO score (NE-SFL, MO-X) and classified three statistically significant risk groups (mild (≤ 3), moderate ($4 \leq \text{NEMO} \leq 5$) and high (≥ 6) risk of sepsis) with an AUC of 0.98 in the study and 0.955 in the validation group.

Shaikh MS *et al.* (2021)

Ensuing adequate mixing of blood samples before analysis—A proposed method for verification of satisfactory sample mixing by automated red blood cell count analyzers.
Int J Lab Hematol; 43(3): e141

<https://onlinelibrary.wiley.com/doi/full/10.1111/ijlh.13447>

Summary: The authors report an excellent correlation (r value of 0.99) between manual and automated blood sample mixing with a minimal bias (0.009), proving an exceptional pre-analysis mixing of samples on the XN-1000 analyser.

Comar SR *et al.* (2021)

Early detection of *Candida parapsilosis* sepsis in peripheral blood as a result of cytographic changes on the Sysmex XN-3000 hematology analyzer.
Int J Lab Hematol; 43(6): e280

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13566>

Summary: A case review that describes specific WNR and WDF scattergram patterns of a patient with *Candida parapsilosis* sepsis. The authors propose careful overall observation of all information provided by the automated blood count including thorough analysis of scattergrams that might enable early diagnosis of invasive fungal infection.

Debus J *et al.* (2021)

A case of methaemoglobinaemia interference on the WDF channel on Sysmex XN-Series analysers.
Clin Chem Lab Med; 59(7): e285

<https://www.degruyter.com/document/doi/10.1515/cclm-2020-1704/html>

Summary: This report is about a case of acquired methaemoglobinaemia resulting in “WDF abnormal scattergram” flagging on XN-1000 and XE-2100. Interferences were shown to be reduced in the course of therapy. The authors suggested interferences with the reagent reaction in line with existing literature.

Ortiz A et al. (2020)

Performance Comparison of Sysmex Hematology Analyzers XN-550 and XN-10.
Sysmex J Int; 30(1): 9

Free online:

https://www.sysmex.co.jp/en/products_solutions/library/journal/vol30_no1/summary02/vol30_1_02.pdf

Summary: The XN-550 is highly reliable with functionality comparable to the XN-10. It has shown high correlation coefficients and excellent comparative performance in all CBC, DIFF and RET parameters (except BASO%). In this study the overall flagging comparison was excellent among the XN-10, the XN-550 and the manual differential.

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>

Summary: 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.

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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12522/abstract>

Summary: 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).

Scand J Clin Lab Invest; 76(6): 465

<http://www.tandfonline.com/doi/full/10.1080/00365513.2016.1199049?scroll=top&needAccess=true>

Summary: Using the biomedical validation criteria, 21.3 % of samples triggered a smear review in this study. Modification of four criteria reduced the number of smears from 21.3 % to 15.0 % without loss of clinical value.

Arneth B *et al.* (2015)

Technology and New Fluorescence Flow Cytometry Parameters in Hematological Analyzers.
J Clin Lab Anal; 29(3): 175

<http://onlinelibrary.wiley.com/doi/10.1002/jcla.21747/abstract>

Summary: 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.

Seo JY *et al.* (2015)

Performance evaluation of the new hematology analyzer Sysmex XN-series.
Int J Lab Hematol; 37(2): 155

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12254/abstract>

Summary: 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/ μ L the XN provided an accurate WBC count using the Low WBC mode.

Bruegel M *et al.* (2015)

Comparison of five automated hematology analyzers in a university hospital setting: Abbott Cell-Dyn Sapphire, Beckman Coulter DxH 800, Siemens Advia 2120i, Sysmex XE-5000, and Sysmex XN-2000.
Clin Chem Lab Med; 53(7): 1057

<http://www.degruyter.com/view/j/cclm.2015.53.issue-7/cclm-2014-0945/cclm-2014-0945.xml>

Summary: 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.

Tabé Y *et al.* (2015)

Performance evaluation of the digital cell imaging analyzer DI-60 integrated into the fully automated Sysmex XN hematology analyzer system.
Clin Chem Lab Med; 53(2): 281

<http://www.degruyter.com/view/j/cclm.2015.53.issue-2/cclm-2014-0445/cclm-2014-0445.xml>

Summary: 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.

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

<https://academic.oup.com/jmicro/article-abstract/64/5/305/1989335?redirectedFrom=fulltext>

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

Genevieve F *et al.* (2014)

Smear microscopy revision: propositions by the GFHC.

feuillet de Biologie; VOL LVI N° 317

<http://www.gfhc.fr/upload/smear-microscopic-revision.pdf>

Summary: 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.

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.

System J Int; 23(1): 1

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

Summary: 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

<http://jcp.bmj.com/content/65/11/1024.abstract> Available from Sysmex upon request.

Summary: In this study 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.

Reference intervals

NEW

Becker M *et al.* (2022)

Differences between capillary and venous blood counts in children—A data mining approach
Int J Lab Hematol; 44(4): 729

Freeonline: <https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13846>

Summary: In this multicentric study the differences between capillary and venous bloods were investigated in paediatric samples specifying a delta for the CBC parameters dependant on measurement range of the parameter value, time difference in sampling and age of the patient.

NEW

Mrosewski I *et al.* (2021)

Indirectly determined hematology reference intervals for pediatric patients in Berlin and Brandenburg
Clin Chem Lab Med; 60(3): 408

<https://www.degruyter.com/document/doi/10.1515/cclm-2021-0853/html>

Summary: The study presents indirectly determined CBC reference intervals (RI) for paediatric patients (0-18 years) in Berlin and Brandenburg area in Germany.

L van Pelt J *et al.* (2022)

Reference intervals for Sysmex XN hematological parameters as assessed in the Dutch Lifelines cohort
Clin Chem Lab Med; 60(6): 907

Freeonline: <https://www.degruyter.com/document/doi/10.1515/cclm-2022-0094/html>

Summary: The publication provides reference intervals for 105 XN parameters (incl. functional and cell activation parameters) based on data of 15,803 healthy individuals from the Lifelines cohort in the Netherlands. The reference intervals were calculated in accordance to the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) recommended statistical methods.

Dockree S *et al.* (2021)

White blood cells in pregnancy: reference intervals for before and after delivery
EBioMedicine; 74: 102715

Freeonline: [https://www.thelancet.com/journals/ebiom/article/PIIS2352-3964\(21\)00509-0/fulltext](https://www.thelancet.com/journals/ebiom/article/PIIS2352-3964(21)00509-0/fulltext)

Summary: The study established pregnancy-specific reference intervals for WBC subtypes for use between 8-40 weeks of gestational age and 7-21 days postnatally based on 80,637 blood measurements from 24,318 women from the UK.

Wilson S *et al.* (2021)

Continuous reference curves for common hematology markers in the CALIPER cohort of healthy children and adolescents on the Sysmex XN-3000 system
Int J Lab Hematol; 43(6): 1394

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13670>

Summary: First study that generated continuous reference intervals (curves) of healthy children and adolescents for 19 haematological XN parameters. Seven parameters required sex-specific reference curves. Continuous reference intervals were found to be accurate estimate of haematological reference ranges over the paediatric age range.

Angelo A *et al.* (2021)

Umbilical cord blood hematological parameters reference interval for newborns from Addis Ababa, Ethiopia.
BMC Pediatrics; 21: 275

Free online: <https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-021-02722-z>

Summary: This pilot study enrolled 139 umbilical cord blood samples from healthy newborns to establish reference values for the KX-21N. For WBC, RBC, and NEUT significant differences were found between caesarean and natural birth.

Florin L *et al.* (2020)

Establishment of common reference intervals for hematology parameters in adults, measured in a multicenter study on the Sysmex XN-series analyzer.
Int J Lab Hematol; 42(3): e110

<https://onlinelibrary.wiley.com/doi/abs/10.1111/ijlh.13151>

Summary: The study provides reference intervals (CBC+DIFF+RET) that could serve as reference values for haematology parameters in adults for laboratories that use the XN-Series analysers.

Bohn MK *et al.* (2020)

Complex biological patterns of hematology parameters in childhood necessitating age- and sex-specific reference intervals for evidence-based clinical interpretation.
Int J Lab Hematol; 42(6): 759

<https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13306>

Summary: The study establishes a comprehensive paediatric (birth to 21 years) reference intervals for haematology parameters using the XN analyser. The data highlight the dynamic haematological profiles observed in healthy children and adolescents and the need for reference interval stratification by age and sex.

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/>

Summary: 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.

Ozarda Y et al. (2017)

Verification of reference intervals in routine clinical laboratories - practical challenges and recommendations.
Clin Chem Lab Med; 57(1): 30

Free online: <https://www.degruyter.com/document/doi/10.1515/cclm-2018-0059/html>

Summary: The opinion paper summarises guidelines and approaches for the verification of reference intervals (RI) in routine clinical laboratories. It gives definitions for common terms, refers to examples and covers challenges such as RI for geriatric and paediatric populations.

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.
Clin Lab; 61: 235

<https://www.clin-lab-publications.com/article/1749>

Summary: 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.

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

<http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12372/abstract>

Summary: 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 72h time frame.

Roehrl MHA *et al.* (2011)

Age-dependent reference ranges for automated assessment of immature granulocytes and clinical significance in an outpatient setting.

Arch Pathol Lab Med; 135: 471

Free online: <https://meridian.allenpress.com/aplm/article/135/4/471/461225/Age-Dependent-Reference-Ranges-for-Automated>

Summary: 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.