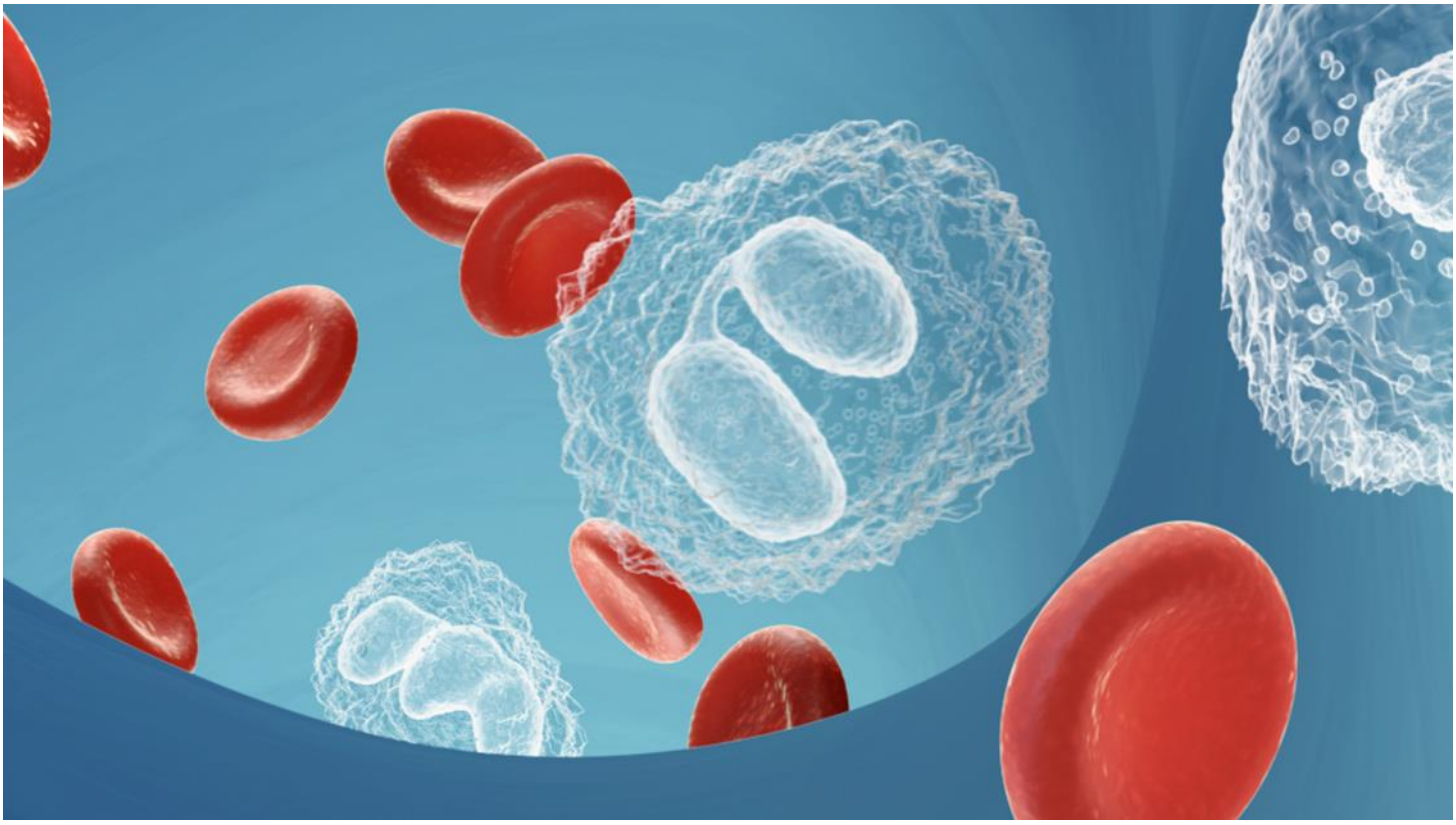
Literature List – White Blood Cells

Customer Information

June 2025



Date: June 2025
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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.

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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.
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Flagging

Ramiah J L *et al*. (2023)

Performance of the automated Sysmex XN-3000 analyser for detecting white blood cell abnormalities in South Africa.
Afr J Lab Med; 12(1): 2140

Free online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10716597/

Summary: A comparison study between WBC flagging and microscopic evaluation in 250 samples (45% haematologic malignancies) showed that 'Blasts?' and 'Abn Lympho?' had a sensitivity of 96.3% and 90% respectively, and a specificity of 84.9% and 96.3%. Low WBC count, chemotherapy, presence of malignancy and/or infection were factors that were associated with discrepant results between flagging and microscopy.

Dedeene 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/fr/revues/abc/e-docs/can_the_72_hour_rule_based_on_blast_abn_lymph_flag_on_sysmex_xn_10_optimize_the_workflow_in_hematology_laboratory__315069/article.phtml

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 in this study.

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: The authors concluded that '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: In this study, 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."

Lymphocytes

Chiriac R *et al*. (2024)

Differential Diagnosis of Lymphocytosis in Routine Laboratory Practice: Contribution of Lymphocyte Parameters Generated by the New Sysmex XR-1000 Hematology Analyzer.
Int J Lab Hematol; 47(2): 345

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.14405

Summary: A study of lymphocyte-related parameters in 288 samples with lymphocytosis (>5 x 10^9/L) showed that LY-X, LY-Y and LY-Z were statistically different between reactive samples (n=100) and several groups of T- and B-cell malignancies (n=188).

Kallen ME *et al*. (2024)

Carvykti CAR T-cell morphology in cellavision peripheral smear reviews.
J Hematop; 17(4): 231

https://link.springer.com/article/10.1007/s12308-024-00591-w

Summary: The authors report on four patients and their lymphocyte morphology of CAR T-cell expansion in the context of CAR T-cell therapy. CellaVision DM9600 confirmed the expansion of atypical lymphocytes (CAR T-cells) with kinetics very similar to those reported by Faude S *et al*. 2021.

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+).

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). HFLC predicted the presence of atypical lymphocytes in the blood smear with an 80% sensitivity in this study.

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

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

Free online: http://onlinelibrary.wiley.com/doi/10.1002/jcla.21744/abstract

Summary: The authors combined the 'Blasts/Abn Lympho?' flag with the LY-X and LY-Y parameters 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 could 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 authors showed that Sysmex XE-5000 was 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

Cornet E *et al*. (2024)

Applicability of mono dysplasia score on the new Sysmex XR analyzer range to predict diagnosis of chronic myelomonocytic leukaemia.
Int J Lab Hematol; 46(5): 971

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.14296?af=R

Summary: A study of 316 patients with monocytosis showed that a mono-dysplasia score > 0.16 calculated on XR-Series could differentiate CMML samples (n=22) from reactive monocytosis cases (n=294) with an AUC of 0.994, sensitivity 100% and specificity of 95.2%.

Kouame H *et al*. (2023)

Monocytosis / Monocytic Dysplasia: Testing a New Diagnostic Tool Using Sysmex XN Analyzer Parameters.
AHRJ; 6(3): 104

Free online: : https://journalahrj.com/index.php/AHRJ/article/view/143/285

Summary: A study in 263 patients with monocytosis (≥1x10^9/L and >10%) showed that the mono-dysplasia score (described in Schillinger F *et al.* 2018) had a sensitivity of 100% and a specificity of 96.4% in identifying samples with monocytic dysplasia.

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.lrjournal.com/article/S0145-2126(13)00074-X/abstract

Summary: The authors found that 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

Kutnik P *et al*. (2024)

Nutritional responsiveness affects novel neutrophil parameters and reduces in-hospital mortality and costs in elective cancer oesophagectomy – a single-centre, prospective, observational study.
Anaesthesiol Intensive Ther; 56(1): 77

https://www.termedia.pl/Nutritional-responsiveness-affects-novel-neutrophil-parameters-and-reduces-in-hospital-mortality-and-costs-in-elective-cancer-oesophagectomy-a-single-centre-prospective-observational-study,118,52538,0,1.html

Summary: In this observational study the parameters NEUT-RI and NEUT-GI were correlated with the nutritional status of patients (n=25), who were scheduled for elective oesophagectomy due to cancer. Statistically significant differences in the preoperative NEUT-RI (48.6 vs. 53.4, p=0.03) and NEUT-GI (154.6 vs. 159.3, p=0.02) values were observed between patients who responded to nutritional intervention (n=18) and patients who did not (n=7).

Costa RM *et al*. (2024)

Early diagnosis of severe illness in an outpatient – the Sysmex XN's neutrophil reactivity parameter.
Clin Chem Lab Med; 62(8): e178

https://www.degruyter.com/document/doi/10.1515/cclm-2023-1406/html

Summary: In this case report from a patient with lung cancer, routine CBC results were in line with patient history, except for a high NEUT-RI value. Further investigation revealed early-stage peritonitis, which was asymptomatic likely due to cancer medication.

Fedorov K *et al*. (2023)

Identifying Neutrophil Extracellular Traps (NETs) in Blood Samples Using Peripheral Smear Autoanalyzers.
Life (Basel); 13(3): 623

Free online: https://www.mdpi.com/2075-1729/13/3/623

Summary: The authors revealed that the smudge cell category of CellaVision may contain two distinct populations of leukocytes: degenerated lymphocytes and neutrophils exhibiting Neutrophil Extracellular Traps (NETs). This study suggests NET-like smudge cells are not an artifact of smear preparation, are identified in the high SFL area of the WNR scattergram, and express NETs markers identifiable with immunohistochemistry and flow cytometry.

Mantovani EMA *et al*. (2023)

The Potential Role of Neutrophil-Reactive Intensity (NEUT-RI) in the Diagnosis of Sepsis in Critically Ill Patients: A Retrospective Cohort Study.
Diagnostics (Basel); 13(10): 1781

Free online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10217715/

Summary: In this study, NEUT-RI showed an AUC of 0.826 in differentiating septic (n=46) from non-septic (n=50) patients on admission to the ICU. Its negative predictive value (87.4%) was superior to that of PCT (83.9%) and CRP (86.6%) but not significantly influenced by renal failure. The authors concluded that NEUT-RI values, together with clinical signs and currently used inflammatory biomarkers, could be useful in the early diagnosis of sepsis.

Bhansaly P *et al*. (2022)

Evaluation of Immature Granulocyte Count as the Earliest Biomarker for Sepsis.
Indian J Crit Care Med; 26(2): 216

Free online: https://www.ijccm.org/doi/pdf/10.5005/jp-journals-10071-23920

Summary: The authors found that IG% and IG# gave an earlier indication of the onset of sepsis than serum procalcitonin and lactate. An increase in IG%/# was found in patients up to 24h before the onset of sepsis according to Sepsis-3 criteria.

Cetin N *et al*. (2022)

Immature granulocytes as biomarkers of inflammation in children with predialysis chronic kidney disease.
Pediatr Nephrol; 38(1): 219

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.

Lu Q *et al*. (2022)

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

Free online: https://link.springer.com/article/10.1007/s12308-022-00484-w

Summary: In this study, 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

Free online: https://bmcpulmmed.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.

Güngör A *et al*. (2021)

Utility of biomarkers in predicting complicated appendicitis: can immature granulocyte percentage and C-reactive protein be used?
Postgrad Med;133(7): 817

https://www.tandfonline.com/doi/abs/10.1080/00325481.2021.1948306?journalCode=ipgm20

Summary: In this study, the best parameters for prediction of complicated appendicitis were found to be IG% (cutoff > 0.35, AUC 0.82, sensitivity 85.4, specificity 61.5) and CRP (cutoff > 33.9, AUC 0.82, sensitivity 75.7, specificity 73.0).

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

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
https://www.sysmex.co.jp/en/products_solutions/library/journal/vol29_no1/summary02.html

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: In this study, 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://journals.lww.com/shockjournal/Fulltext/2017/03000/Evidence_of_Netosis_in_Septic_Shock_Induced.8.aspx

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://journals.lww.com/annalsofsurgery/Abstract/2017/06000/Neutrophil_Dysfunction,_Immature_Granulocytes,_and.32.aspx

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 of this study.

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#.VeRGSfJUCCp

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: https://bmcimmunol.biomedcentral.com/articles/10.1186/1471-2172-14-8

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.”

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, in this study. 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: https://academic.oup.com/ajcp/article/128/3/454/1760150?login=false

Summary: The result of this study indicates 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 authors found that IG count correlated with visual counts thus potentially improving screening and monitoring of various pathological conditions and reducing turnaround time.

Intensive Care Infection Score (ICIS RUO*)

* RUO is the abbreviation for 'Research Use Only', which indicates that an *in vitro* diagnostic medical purpose has not been validated by the manufacturer. Health institutions that intend to use RUO product results for diagnostic purposes do so under their own responsibility and must observe the rules and regulations applicable in their region, such as Regulation (EU) 2017/746 (IVD-R) for the EU. Sysmex cannot support such diagnostic use.

ICIS is currently provided as a licence-protected RUO add-on in the *Extended* IPU work area manager.

NEW

Vrbacky F *et al*. (2025)

Intensive Care Infection Score (ICIS) is an Early Marker for Infection in Time of Admission to Intensive Care Units.
Int J Lab Hematol; online ahead of print

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.14468

Summary: In this cohort of 102 adult ICU patients (n=30 infected, n=72 non-infected), ICIS RUO demonstrated a diagnostic performance for early infection detection at admission, with an AUC of 0.958, outperforming CRP, PCT and IL6. An ICIS RUO cut-off of ≥4 provided a high sensitivity and specificity (93.3% and 84.2%, respectively). Infected patients had significantly higher levels of NEUT-SFL, NEUT#, HFLC#, and IG# ($p < 0.0031$).

van der Geest PJ *et al*. (2016)

The intensive care infection score - a novel marker for the prediction of infection and its severity.
Crit Care; 20(1): 180

https://ccforum.biomedcentral.com/articles/10.1186/s13054-016-1366-6

Summary: ICIS RUO is potentially useful for the prediction of infections in critically ill patients and was shown to be non-inferior to CRP and PCT in this study.

Weimann K *et al*. (2015)

Intensive Care Infection Score--A new approach to distinguish between infectious and noninfectious processes in intensive care and medicosurgical patients.
J Int Med Res; 43(3): 435

Free online: https://journals.sagepub.com/doi/10.1177/0300060514557711

Summary: In this study, ICIS RUO showed better discriminatory power than CRP and PCT for differentiating between infected and non-infected ICU patients, especially in post-operative patients, and could therefore be useful as a decision-making aid for antibiotic treatment.

Nierhaus A *et al*. (2012)

Use of a weighted, automated analysis of the differential blood count to differentiate sepsis from non-infectious systemic inflammation: the intensive care infection score (ICIS).
Inflamm Allergy Drug Targets; 11(2): 109

https://www.eurekaselect.com/article/34637

Summary: The Intensive Care Infection Score RUO (ICIS RUO) consists of multiple differential blood count parameters and provides promising potential for reliably and swiftly discriminating sepsis from systemic inflammation (SIRS) in the first critical hours at the ICU, in this study.

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: The authors found a good correlation between the XN-Series and XE-Series for all parameters. The XN-Series dramatically reduced the smear rate (by 58%), in this study. 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

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 leukocytopenic samples than the whole blood (WB) mode.

Haematopoietic Progenitor Cells (HPC)

Hagenkötter M *et al.* (2024)

Comparison of peripheral blood automated hematopoietic progenitor cell count and flow cytometric CD34+ cell count.
J Clin Apher; 39(3): e22114

https://onlinelibrary.wiley.com/doi/10.1002/jca.22114

Summary: A study in 41 patients that underwent apheresis for autologous stem cell transplantation showed that HPC had a very good correlation with CD34+ (r=0.884 in 143 measurements) in mobilised peripheral blood. The correlation in multiple myeloma (r=0.840 in 78 measurements) was lower than in non-myeloma patients (r=0.934 in 65 measurements).

Brochier A *et al.* (2024)

The added value of automated HPC count: detecting clinically important interferences on the flow cytometric CD34+ cell count.
Clin Chem Lab Med; 62(7): e160

https://www.degruyter.com/document/doi/10.1515/cclm-2023-0601/html

Summary: This case report of a peripheral T-cell lymphoma patient describes discrepancies between $CD34^+$ flow count results and HPC count. The clinician decided to initiate apheresis due to increasing HPC counts, because the $CD34^+$ was zero. Investigation of the discrepancy revealed background staining from the patient's plasma in the flow cytometric $CD34^+$ cell count, obscuring the $CD34^+$ stem cells. The authors emphasised the added value of the HPC as complementary method to flow cytometry.

Lavalleye T *et al.* (2024)

Method comparison between hematopoietic progenitor cell and CD34+ cell counts in hematopoietic stem cell collection.
Transfusion; 64(9): 1743

https://onlinelibrary.wiley.com/doi/10.1111/trf.17937

Summary: A study in allogeneic and autologous stem cell transplantation donors (n=133 samples) showed that HPC had a varying performance to predict the optimal apheresis starting point (AUC from 0.737 to 0.954). By applying a positive and a negative cut-off for adequate or inadequate stem cell mobilisation respectively, 81% of $CD34^+$ flow cytometry measurements would have been saved in healthy donors, 63% in lymphoma patients, and 24% in multiple myeloma patients.

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

https://onlinelibrary.wiley.com/doi/epdf/10.1111/ijlh.13341

Summary: A study on allogeneic and autologous 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 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/bt/article/view/192

Summary: The HPC mode 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, in this study.

Grommé M *et al.* (2017)

Multicenter study to evaluate a new enumeration method for hematopoietic stem cell collection management.
Transfusion; 57(8): 1949

Free online: http://onlinelibrary.wiley.com/wol1/doi/10.1111/trf.14183/full

Summary: In this study, HPC 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

Summary: In this study, HPC counts from the XN-Series were more accurate than 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, automated haematopoietic progenitor cell analysis was 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 HPC value in pre-apheresis blood and apheresis products.

General

NEW

Mardia AI *et al.* (2025)

The Potential Role of Neutrophil Reactivity Intensity and Reactive Lymphocytes as Extended Hematological Parameters to Detect Active Systemic Lupus Erythematosus.
Int J Rheum Dis; 27(12): e15449

https://onlinelibrary.wiley.com/doi/10.1111/1756-185X.15449

Summary: In this study, patients with active systemic lupus erythematosus (SLE) exhibited significantly higher NEUT-RI values (51.5 vs. 49.6 FL, p=0.004) and significantly lower RE-LYMP values (0.09 vs. 0.14 × 10^3/mm^3, p=0.024) and higher NEUT-RI/RE-LYMP ratio (0.52 vs. 0.35, p=0.012) between active and inactive SLE patients.

NEW

Egger M *et al.* (2025)

Impact of biological and genetic features of leukemic cells on the occurrence of “shark fins” in the WPC channel scattergrams of the Sysmex XN hematology analyzers in patients with chronic lymphocytic leukemia.
Clin Chem Lab Med; online ahead of print

Free online: https://www.degruyterbrill.com/document/doi/10.1515/cclm-2025-0115/html

Summary: A study in 95 chronic lymphocytic leukaemia samples evaluated the correlation of certain genetic features with the appearance of a 'shark fin' area in the WPC scattergram. High lymphocyte count along with the presence of an IGHV mutation, the absence of del(17p), an unmutated TP53 or high percentage of smudge cells in the smear correlated with the presence of cells in that area.

NEW

Coussee A *et al.* (2025)

Evaluating the Performance of the New Sysmex XR-Series Haematology Analyser: A Comparative Study with the Sysmex XN-Series.
LabMed; 2(1): 5

Free online: https://www.mdpi.com/2813-9038/2/1/5

Summary: In this comparative analytical performance study of the XR-Series and XN-Series analysers the authors demonstrated highly comparable precision, method comparison and flagging.

Kowalska-Kępczyńska A *et al.* (2024)

Extended Inflammation Parameters (EIP) as Markers of Inflammation in Systemic Sclerosis.
Int J Inflam; 2024: 3786206

Free online: https://onlinelibrary.wiley.com/doi/10.1155/2024/3786206

Summary: A study in patients with systemic sclerosis (n=28), an autoimmune disease characterised by chronic systemic inflammation, showed that NEUT-RI, NEUT-GI, RE-LYMP# and IL-6 were increased compared to healthy controls (n=29). RE-LYMP# correlated with IL-6 (r=0.45) and ESR (r=0.53).

Herawati S *et al.* (2024)

Integrating Routine Hematological and Extended Inflammatory Parameters as a Novel Approach for Timely Diagnosis and Prognosis in Sepsis Management.
Diagnostics; 14(9): 956

Free online: https://www.mdpi.com/2075-4418/14/9/956

Summary: A study in 78 hospitalised patients showed that patients with sepsis (n=39) had increased WBC, NEUT#/%, IG#, NEUT-RI, NEUT-GI, AS-LYMP# and RE-LYMP# compared to non-sepsis (n=39) at day of admission. A regression model with WBC, IG# and the EIP had an AUC of 0.924 to distinguish sepsis from non-sepsis patients and an AUC of 0.991 to distinguish sepsis patients from healthy controls (n=33).

Tabata M *et al.* (2024)

Performance evaluation and user experience of BT-50 transportation unit with automated and scheduled quality control measurements.
Clin Chem Lab Med; 62(12): 2461

Free online: https://www.degruyter.com/document/doi/10.1515/cclm-2024-0220/html

Summary: The authors evaluated the performance of the BT-50 and the manual method using XN Check Levels 1, 2 and 3 and the results were equivalent. For PLT, BT-50 showed lower variability compared to the manual method. The BT-50 streamlined the workflow, reduced operator workload and provided standardised control measurements.

Kaneda M *et al.* (2024)

Time-dependent changes in cell population data obtained using Sysmex XN-series hematology analyzer in bacterial infections.
J Infect Chemother; 30(10): 983

https://www.jiac-j.com/article/S1341-321X(24)00083-7/abstract

Summary: A study in patients with acute bacterial infection that developed sepsis (n=25) showed that NE-WY peaked on d0, the starting point of antibiotic treatment, and was then gradually decreasing on d1 and d3, when all patients improved. NE-WY also correlated with the blood bacterial load on d0 and d1 in PCR-proven infections irrespective of the sepsis status (n=22).

Fujimaki K *et al.* (2024)

Performance evaluation of the new Sysmex XR-Series haematology analyser.
Pract Lab Med; 39: e00370

Free online: https://www.sciencedirect.com/science/article/pii/S2352551724000167?via%3Dihub

Summary: In this study, the XR analyser had very good analytical performance, and highly comparable results to the predecessor XN analyser in all investigated parameters, flags and workflow aspects. The correlation coefficients between the two systems for the parameters tested were greater than 0.909. High sensitivities for the detection of abnormal cells were observed for the 'Blasts/Abn Lympho?' flag (XN: 100%, XR: 99.0%) and WPC abnormal flags ('Blasts?' or 'Abn Lympho?') (XN: 97.0%, XR: 96.0%).

Coutaz C *et al.* (2024)

Evaluation of the Sysmex XQ-320 three-part differential haematology analyser and its flagging capabilities.
J Clin Lab Anal; 38(4): e25017

Free online: https://onlinelibrary.wiley.com/doi/10.1002/jcla.25017

Summary: The authors found an excellent analytical performance for XQ-320 in selected categories. A method comparison with XN-9000 and XP-300 in a cohort of 493 samples enriched with abnormalities showed correlation values greater than 0.94 for the majority of the 20 reportable parameters, with better results than XP-300. Specific parameter patterns on XQ-320 could differentiate abnormal samples that were only identified by the extensive XN-9000 flagging algorithms.

Akbari P *et al.* (2023)

A genome-wide association study of blood cell morphology identifies cellular proteins implicated in disease aetiology.
Nat Commun; 14(1): 5023

Free online: https://www.nature.com/articles/s41467-023-40679-y

Summary: The authors performed the first genome-wide association study to investigate the genetic basis of 63 blood cell morphological traits (Sysmex parameters). They identified key cellular proteins associated with disease aetiologies (e.g. multiple sclerosis) and highlighted the importance of genetic factors in influencing blood cell parameters (e.g. ZFPM2 gene expression for platelet granularity).

Bouriche L *et al.* (2023)

Detection of dysplasia in peripheral blood: Proposal of an algorithm to detect myelodysplastic syndromes and chronic myelomonocytic leukemias on a high-speed technical platform using the Sysmex XN™ analyser.
Int J Lab Hematol; 46(2): 286

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.14217

Summary: A decision tree utilising the MDS-CBC and mono-dysplasia scores had a 94.4% sensitivity and 91.4% specificity in identifying MDS (n=18) and CMML (n=18) samples within a cohort of 749. The authors showed that routine implementation of the tree compared to using the recommended cytopenia or monocytosis criteria in over 25,000 samples significantly reduced the smear workload.

Ho SF *et al.* (2023)

Exploring Extended White Blood Cell Parameters for the Evaluation of Sepsis among Patients Admitted to Intensive Care Units.
Diagnostics (Basel); 13(14): 2445

Free online: https://www.mdpi.com/2075-4418/13/14/2445

Summary: The authors observed a specific pattern of CBC parameters (including EIP) and biochemical parameters (CRP, PCT and IL-6) in a small cohort of sepsis (n=30) and non-sepsis (n=23) ICU patients. The combination of certain CBC parameters and EIP was effective in predicting worse outcome. The AUC for the combined parameters (AUC=0.918) was highest compared to the classical markers (SOFA Score = 0.631; CRP = 0.611; PCT= 0.639; IL-6= 0.531).

Vanrenterghem M *et al.* (2023)

Carcinocythemia in metastatic breast cancer detected by high fluorescent signals on an automated Sysmex XN-9100 hematological cell counter.
Int J Lab Hematol; 45(5): 625

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.14112

Summary: This case report describes a patient with suspected microangiopathic haemolytic anaemia (prominence of NRBC, RET# 0.379 x 10^12/L), 4-5% schistocytes, elevated LDH (1823 U/L)) together with suspicious high fluorescence cells. Smear results and other tests have proven the presence of circulating non-haematological malignant tumour cells, a rare phenomenon called carcinocythaemia.

Dai Q *et al.* (2023)

Spurious low WBC count in the WNR channel of Sysmex XN-9000 hematology analyzer in a case with leukocyte aggregation.
Clin Chem Lab Med; 61(7): e131

https://www.degruyter.com/document/doi/10.1515/cclm-2022-1308/html

Summary: In this case study a sample of an 11-year-old girl infected with *Cryptococcus neoformans* led to discrepancies between WNR and WDF channel results, correctly identified by the XN-9000, due to excessive hyaluronic acid produced from the pathogen.

Pozdnyakova O *et al.* (2022)

Beyond the routine CBC: machine learning and statistical analyses identify research CBC parameter associations with myelodysplastic syndromes and specific underlying pathogenic variants.
J Clin Pathol; 76(9): 624

https://jcp.bmj.com/content/early/2022/05/15/jclinpath-2021-207860

Summary: The authors created a predictive model to identify myelodysplastic syndrome (MDS) samples (n=102) from cytopenic (n=145) or other control samples (n=484) by using haematology parameters. The model had AUC 0.98, sensitivity 90%, specificity 96% and NPV 99%. Neutrophil parameters and IPF were found to have high predictive value for the model.

Zhu J *et al.* (2022)

Machine learning-based improvement of MDS-CBC score brings platelets into the limelight to optimize smear review in the hematology laboratory.
BMC Cancer; 22(1): 972

Free online: https://bmccancer.biomedcentral.com/articles/10.1186/s12885-022-10059-8

Summary: A two-step algorithm, triggered by cytopenia, and utilising the MDS-CBC score and IPF, correctly separated myelodysplastic (MDS) samples (n=168) from other non-clonal cytopenic samples (n=357) with a sensitivity of 88.7% and a specificity of 95.8%. The algorithm had a 96.4% classification rate for MDS and 95.8% for the cytopenic controls, in this study.

Post A *et al.* (2021)

Infection Manager System (IMS) as a new hemocytometry-based bacteremia detection tool: A diagnostic accuracy study in a malaria-endemic area of Burkina Faso.
PLoS Negl Trop Dis; 15(3): e0009187

https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0009187

Summary: A study in 914 patients with acute febrile illness showed that the Infection Manager System (IMS) detected the presence of bacteraemia with a sensitivity of 92.2% and a specificity of 70.9%.

The performance varied dependant on age group and concurrent malaria infection. IMS outperformed C-reactive protein (CRP) and procalcitonin (PCT) in detecting bacteraemia.

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 cytografic 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 parapsilopsis* 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 Abn 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.

Boutault R *et al.* (2018)

A novel complete blood count-based score to screen for myelodysplastic syndrome in cytopenic patients.
Br J Haematol; 183(5): 736

Free online: https://onlinelibrary.wiley.com/doi/10.1111/bjh.15626

Summary: The authors suggested an MDS-CBC multiparametric score as a screening tool for MDS patients by combining absolute neutrophil count (ANC), mean corpuscular volume (MCV), and median neutrophil complexity width of dispersion (NE-WX). The score had a sensitivity of 86% and a specificity of 88% in the leading cohort.

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≤NEMO≤5) and high (≥6) risk of sepsis) with an AUC of 0.98 in the study and 0.955 in the validation group.

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: In this study, the pocH-100*i* 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 precision and reportable range were also consistent with specifications by the manufacturer.

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 in this study, 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

Free online: 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.

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, in this study.

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.
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: In 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: The authors used flow cytometry software and electron microscopy methods 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.
feuillets 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.
Sysmex 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

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.

Van Hecke I *et al*. (2010)

Evaluation of the Sysmex pocH-1001 haematology analyser in an outdoor oncology service.
Acta Clin Belg; 65: 248

https://www.tandfonline.com/doi/abs/10.1179/acb.2010.054

Summary: In this study, Sysmex pocH-100*i* produces reliable results in the normal and in the lower ranges. The authors concluded that in a well-controlled management plan the Sysmex pocH-100*i* is suitable for near patient testing in oncology.

Whisler S *et al*. (2005)

Performance Evaluation of the Sysmex pocH-100i Automated Hematology Analyzer.
Lab Hematol; 11: 107

https://pubmed.ncbi.nlm.nih.gov/16024334/

Summary: In this performance evaluation of the poch-100*i* and comparison with KX-21N and XE-2100 showed excellent results in this study. A reference range for a healthy population was also established by the authors.

Briggs C *et al*. (2003)

Performance evaluation of a New Compact Hematology Analyzer, the Sysmex pocH-100i.
Lab Hematol; 9(4): 225

https://pubmed.ncbi.nlm.nih.gov/14649465/

Summary: In this performance evaluation of the pocH-100*i* and comparison with KX-21N showed excellent results. This study illustrates the clinical potential for use for accurate CBC results in a low-volume laboratory or in near-patient testing environment.

Reference intervals

Laugesen K *et al.* (2024)

Paediatric reference intervals for haematology parameters analysed on Sysmex XN-9000: a comparison of methods in the framework of indirect sampling.
Clin Chem Lab Med; 63(4): 812

https://www.degruyter.com/document/doi/10.1515/cclm-2024-1179/html

Summary: The study presents indirectly determined reference intervals (RI) of 13 CBC parameters for paediatric patients (0-18 years) in a Caucasian population (n=10,199) on XN-9000. Data were stratified by age and sex where statistically necessary (except for < 1 year). Comparing to a direct method (Bohn *et al*.) as a verification the authors found only minor differences.

Mrosewski I *et al.* (2023)

Indirectly determined reference intervals for automated white blood cell differentials of pediatric patients in Berlin and Brandenburg.
Clin Chem Lab Med; 61(6): 1116

https://www.degruyter.com/document/doi/10.1515/cclm-2022-1265/html

Summary: The study presents indirectly determined WBC differential reference intervals (RI) for paediatric patients (0-18 years) in Berlin and Brandenburg area in Germany. No RI for DIFF parameters are available for children < 7 months.

Bildirici A *et al.* (2023)

Determination of reference intervals of hemogram with advanced clinical parameters by indirect method on Sysmex XN-1000.
Turk J Biochem; 48(4): 388

Free online: https://www.degruyter.com/document/doi/10.1515/tjb-2022-0287/html?lang=en

Summary: In this study, the CBC+DIFF reference intervals of 68,316 patients aged 18–65 years were determined by indirect method using the non-parametric percentage estimation in Turkish Kastamonu Training and Research Hospital.

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

Free online: 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.

Song MY *et al.* (2021)

Establishment of pediatric reference intervals for complete blood count parameters in capillary blood in Beijing.
Int J Lab Hematol; 43(6): 1363

https://onlinelibrary.wiley.com/doi/10.1111/ijlh.13631

Summary: The authors established reference intervals for 22 CBC+DIFF parameters from capillary blood in 6799 children aged 3 months to 18 years from Beijing area in China.

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

Free online: 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

Free online: 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.

Zierk J *et al*. (2019)

Next-generation reference intervals for pediatric hematology.
Clin Chem Lab Med; 57(10): 1595

https://www.degruyter.com/document/doi/10.1515/cclm-2018-1236/html

Summary: The authors determined percentile charts and z-scores for CBC reference intervals from birth to adulthood. A total of 9,576,910 specimens were gathered from ten German facilities and analysed using predominantly Sysmex X-Class and XN-Class analysers and one Beckman Coulter DxH800 analyser.

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: In this study, 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: In this study, reference values were determined on the XN-Series for the structural neutrophil parameters NEUT-GI, NEUT-RI, and NEUT-WY. In addition, the authors demonstrated a value for NEUT-RI and NEUT-WY to predict IG% values within a 72 hour-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: In this study, the use of appropriate reference ranges made the IG count a powerful haematologic parameter for outpatient care that was associated with differential diagnoses that were distinctly characteristic of that setting.