Evaluation and Clinical Usefulness of the Automated Hematology Analyzer, Sysmex XE-2100™

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The XE-2100, a new automated hematology analyzer, was evaluated focusing particularly on the reproducibility of CBC data, screening ability for leukemic cells, and the potential of the peripheral blood hematopoietic progenitor cell (HPC) measurement to replace CD34⁺ assays in predicting the optimum time for stem cell harvesting. Precision and accuracy were greater than with the current analyzers such as NE-8000™, K-4500™, K-2000™, R-3000™, and Omron Microx HEG-120. In addition, its compact size, ease of operation, and interpretive messages for the laboratory make the analyzer clinically efficacious.

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Key Words WBC Differential, Hematology, Complete Blood Count (CBC), Leukemia, Peripheral Blood Stem Cell (PBSC), Hematopoietic Progenitor Cell (HPC)

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INTRODUCTION

Remarkable progress in the development of automated hematology analyzers has taken place since their introduction more than thirty years ago. For the clinical laboratory, however, several problems remain, such as platelet agglutination, correction of the white blood cell count when nucleated red blood cells are present, and the recognition of abnormal cells of lymphoid origin. The occurrence of adult T cell leukemia (ATL) is common in our laboratory and its detection causes problems. At the same time, there are demands on the laboratory to provide efficient service in the face of an increasing workload and changing medical requirements. New and innovative technology is necessary to satisfy these demands. The newly introduced automated hematology analyzer, the Sysmex XE-2100™ attempts to address such problems. This analyzer employs flow cytometry using semiconductor laser technology (forward scattered light, side scattered light and side fluorescence) in addition to the conventional direct current (DC) and radio-frequency (RF) methods. The following parameters are generated: all components of the traditional CBC (including an optical platelet count), 5-part differential leukocyte count, reticulocyte count and immature reticulocyte fraction (IRF), nucleated red blood cell (NRBC) count, immature granulocyte (IG) count, and the hematopoietic progenitor cell (HPC) count. There is a comprehensive array of flags supported by the unique Q-flag system. The analyzer also provides comprehensive data handling soft ware, can interface with an LIS, and is capable of networking. In the present study, we have compared the performance of the XE-2100 with that of the other analyzers currently in use.

MATERIALS AND METHODS

Specimens and analyzers

Venous blood specimens anticoagulated with K_2EDTA were studied. These were obtained from the routine workload of the Clinical Laboratory of Nagasaki University School of Medicine over a 3 month period. The specimens were analyzed on the XE-2100 and the other analyzers currently in use; NE-8000™, K-4500™, K-2000™, R-3000™ (All Sysmex Corporation analyzers) and the Microx HEG-120 (OMRON).

Cases

For the general instrument evaluation (precision, etc.) specimens were selected at random from the routine workload of the department. For the special study the following specimens were available: acute lymphoblastic leukemia (ALL/L1), 1 case; acute myeloblastic leukemia (AML M2/M7), 2 cases; AML/tri-lineage dysplasia (TLD), 1 case; chronic granulocytic leukemia (CGL), 1 case; CGL in blast crisis, 1 case; myelofibrosis, 1 case; myeloproliferative disease (MPD), 1 case; non-

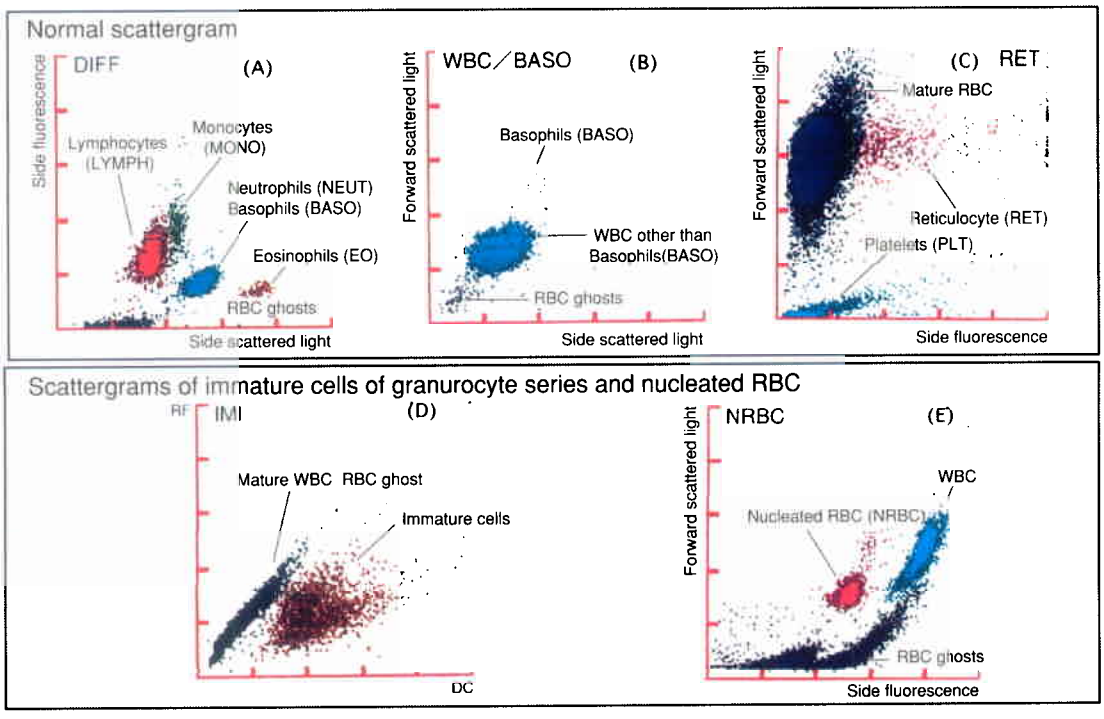


Fig. 1 *Examples of the XE-2100 scattergrams [1] (see text)*

Hodgkin's lymphoma (NHL), 1 case; adult T cell leukemia (ATL), 8 cases; chronic lymphocytic leukemia (CLL), 2 cases; hairy cell leukemia variant (HCL-V), 1 case; large granular lymphocytic leukemia (LGLL), 1 case; leukemic manifestation of NHL, 1 case; myeloma, 1 case; unspecified anemia, 1 case; idiopathic thrombocytopenic purpura (ITP), 1 case; virus infection, 1 case; toxic erythema, 1 case; pneumonia, 1 case; and non hemopoietic malignant tumor, 3 cases.

XE-2100 measurement principles

Detail of the overall principles of measurement will not be described here. Since the main focus of interest lay in the analyzer's performance with specimens from patients with leukemia and related disorders, the relevant scattergrams involving these specific cell types are illustrated in ***Fig. 1.*** These derive from the following analyzer channels:

(A) DIFF channel for WBC 4-part differential (y = side fluorescence {intensity of polymethine staining DNA/RNA}, x = side scattered light {cell content}), (B) WBC/BASO channel for detection of basophils (y = forward scattered light {cell volume}, x = side scattered light {cell content}) , (C) RET channel for detection of reticulocytes (y = forward scattered light {cell volume}, x = side fluorescence {DNA/RNA}), (D) IMI channel for detection of immature WBC and HPC (y = RF {cell density}, x = DC {cell volume}), and (E) NRBC channel for detection of NRBC (y = forward scattered light {cell volume}, x = side fluorescence {DNA/RNA}).

Unlike the K-4500 and the NE-8000 which rely solely on changes in impedance for platelet counting, the XE-2100 offers alternate technologies controlled by a switching algorithm. The first is the traditional sheath flow impedance method (PLT-I) which continues to provide the bulk of the platelet counts in routine practice quite adequately. The second method (PLT-O) employs flow cytometry using a semi-conductor laser, the platelet count being based on forward scattered light and side fluorescence. The switching algorithm comes into operation (1) when there is an abnormality in the platelet volume distribution as perceived by the impedance channel and/or (2) when the platelet count is very low ($< 30 \times 10^3/\mu L$). Under both circumstances the PLT-O is automatically displayed.

Our clinical laboratory has constructed a diagnosis support system for hematopoietic malignant disorders; in the present study, we have also assessed the performance and clinical usefulness of the abnormal and suspect messages generated by the XE-2100.

Within-run precision (reproducibility)

Reproducibility was evaluated for CBC, DIFF, NRBC% and RET‰. Six samples consisting of 1 normal and 5 abnormal samples were analysed 3 to 5 times in closed mode operation.

Correlation

Correlations of DIFF parameters and NRBC% between XE-2100 and HEG-120 (n = 177) and of RET‰ between XE-2100 and R-3000 (n = 36) were performed.

Detection ability for blast cells -Examination of flagging sensitivity-

1) The flagging performance for ALL (L1), AML (M2) and CGL was evaluated.
2) The detection ability (flagging ability of XE-2100) for blast sample (M7 : Blast ratio 80%) was evaluated when diluted with normal mononuclear cells.
3) The flagging performance was validated by visual microscopy of 100-cell differential counts.
4) The usefulness of flagging in lymphoid tumors was evaluated. Using ATL, 5 cases; CLL, 1 case; HCL-V, 1 case; LGLL, 1 case; and leukemic manifestation of NHL, 1 case, the data by manual differential were compared with WBC suspect flags on the XE-2100, and the detection sensitivity of each suspect flag was assessed.

Correlation of platelet counts between the electronic impedance method (PLT-I) and the optical method (PLT-O)

1) PLT-I and PLT-O were compared in a specimen containing megathrombocytes (AML with tri-lineage dysplasia; 1 case).
2) PLT-I and PLT-O were compared when red cell fragments were present.

Evaluation of usefulness of the HPC count prior to stem cell harvesting

Using peripheral blood anticoagulated with K_2EDTA from patients undergoing mobilization therapy prior to stem cell harvesting, correlation between HPC% (from the IMI channel) and $CD34^+$% was studied (along with total WBC, neutrophil, and platelet counts) to determine if the HPC count was a good predictor of the optimum time for stem cell harvesting. $CD34^+$% was determined with PBSC Pro-Count kit (Becton Dickinson Inc.) by a CD45 blast gating method using FACS Calibur (Becton Dickinson Inc.).

RESULTS

Within-run imprecision (reproducibility)

The results of within-run imprecision (reproducibility) for all count parameters are shown in ***Table 1.*** Predictably, coefficients of variation were high at very low count levels. However, overall precision of numerical results for CBC and from the 5-part differential, NRBC and reticulocytes was excellent.

Correlation studies

Fig. 2 shows the generally excellent comparability of the components of the differential white blood cell and NRBC counts performed on the XE-2100 with those on the HEG-120 and for the reticulocyte count on the R-3000.
Higher values in MONO% were obtained on the HEG-120 than on the XE-2100. However, correlation of the XE-2100 monocyte count agreed more closely with manual differential than did HEG-120 counts.

Table 1 *Within-run precision (reproducibility) of XE-2100*

	WBC ($\times10^3/\mu L$)	RBC ($\times10^6/\mu L$)	Hgb (g/dL)	Hct (%)	MCV (fL)	MCH (pg)	MCHC (g/dL)	PLT ($\times10^3/\mu L$)	NEUT (%)	LYMPH (%)	MONO (%)	EO (%)	BASO (%)	NRBC (%)	RET (‰)
MEAN (N=5)	7.01	4.77	14.10	44.1	92.5	29.5	32.0	212.2	54.7	34.2	6.6	3.5	1.0	0.0	9.7
SD	0.10	0.02	0.04	0.19	0.15	0.21	0.19	4.32	0.54	0.51	0.66	0.15	0.17	0.00	0.47
CV(%)	1.41	0.44	0.32	0.44	0.16	0.70	0.61	2.04	1.00	1.49	9.99	4.38	16.09		4.85
MEAN (N=5)	11.91	3.26	9.60	30.3	93.1	29.4	31.6	334.0	62.5	32.0	3.1	2.3	0.1	0.0	34.3
SD	0.11	0.02	0.04	0.15	0.16	0.19	0.19	6.36	0.64	0.54	0.16	0.11	0.07	0.00	0.29
CV(%)	0.94	0.56	0.47	0.49	0.18	0.64	0.61	1.91	1.03	1.66	5.27	4.87	70.71		0.84
MEAN (N=5)	10.49	3.17	9.70	29.3	92.3	30.6	33.2	56.6	82.6	6.6	5.3	2.9	2.6	1.6	64.2
SD	0.12	0.02	0.04	0.18	0.19	0.25	0.28	4.98	0.84	0.79	0.29	0.15	0.34	0.16	1.70
CV(%)	1.19	0.52	0.46	0.61	0.20	0.82	0.85	8.80	1.01	11.89	5.54	5.15	13.04	10.14	2.66
MEAN (N=4)	4.4	3.31	12.60	35.8	108.2	38.0	35.1	359.5	88.4	10.1	1.3	0.2	0.1	0.0	16.3
SD	0.12	0.01	0.05	0.18	0.21	0.24	0.31	6.45	0.14	0.26	0.47	0.00	0.12	0.00	0.85
CV(%)	2.63	0.35	0.40	0.51	0.19	0.62	0.88	1.80	0.16	2.63	37.24	0.00	115.47		5.23
MEAN (N=4)	36.91	3.88	11.90	37.1	95.4	30.6	32.1	41.6	22.9	69.1	7.1	0.6	0.5	0.0	4.7
SD	0.61	0.02	0.08	0.21	0.34	0.36	0.33	0.08	0.35	0.76	0.51	0.06	0.10	0.00	0.48
CV(%)	1.64	0.57	0.69	0.56	0.36	1.17	1.03	0.20	1.54	1.10	7.19	10.50	22.22		10.13
MEAN (N=3)	2.45	1.8	6.90	21.4	118.7	38.1	32.1	18.7	37.5	54.1	6.9	1.2	0.3	3.4	28.3
SD	0.11	0.02	0.06	0.25	0.20	0.21	0.17	2.08	0.95	0.70	0.68	0.35	0.23	0.35	1.01
CV(%)	4.32	1.11	0.84	1.18	0.17	0.55	0.54	11.15	2.52	1.29	9.82	28.47	86.60	10.43	3.59

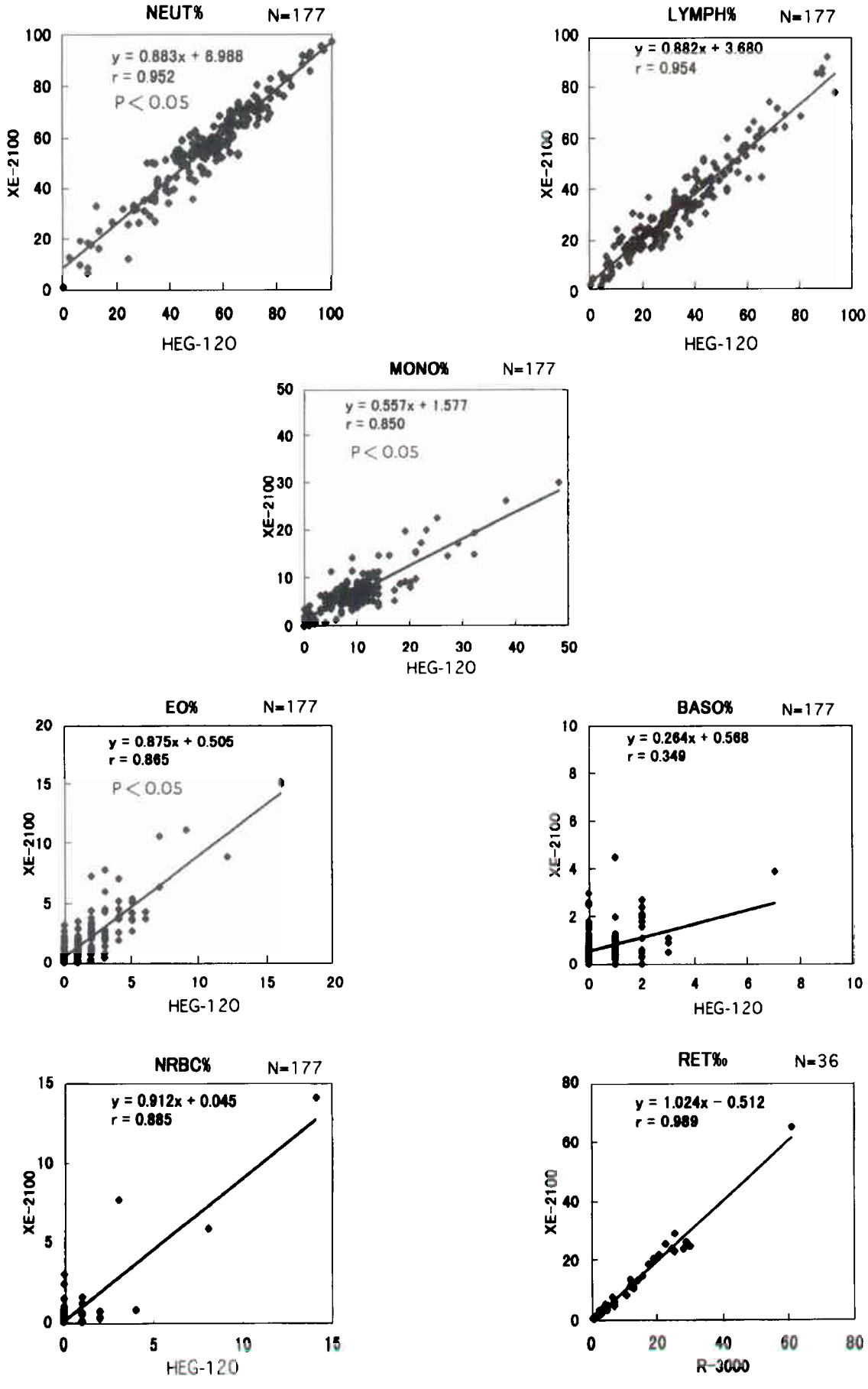


Fig. 2 *Correlation between XE-2100 and current analyzers*

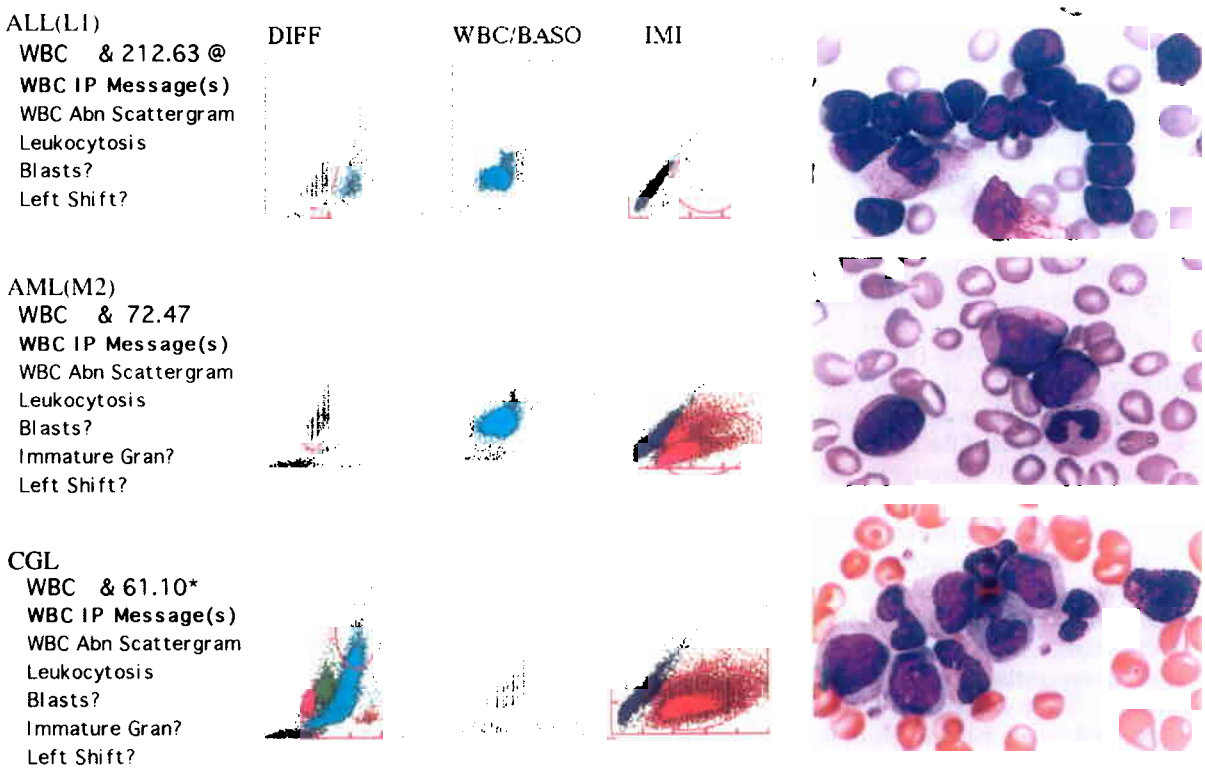


Fig. 3 *DIFF, WBC/BASO and IMI scattergrams and morphological images of leukemic cells in each sample.*
*& : Corrected count, @ : Outside-linearity range, * : Data with low confidence*

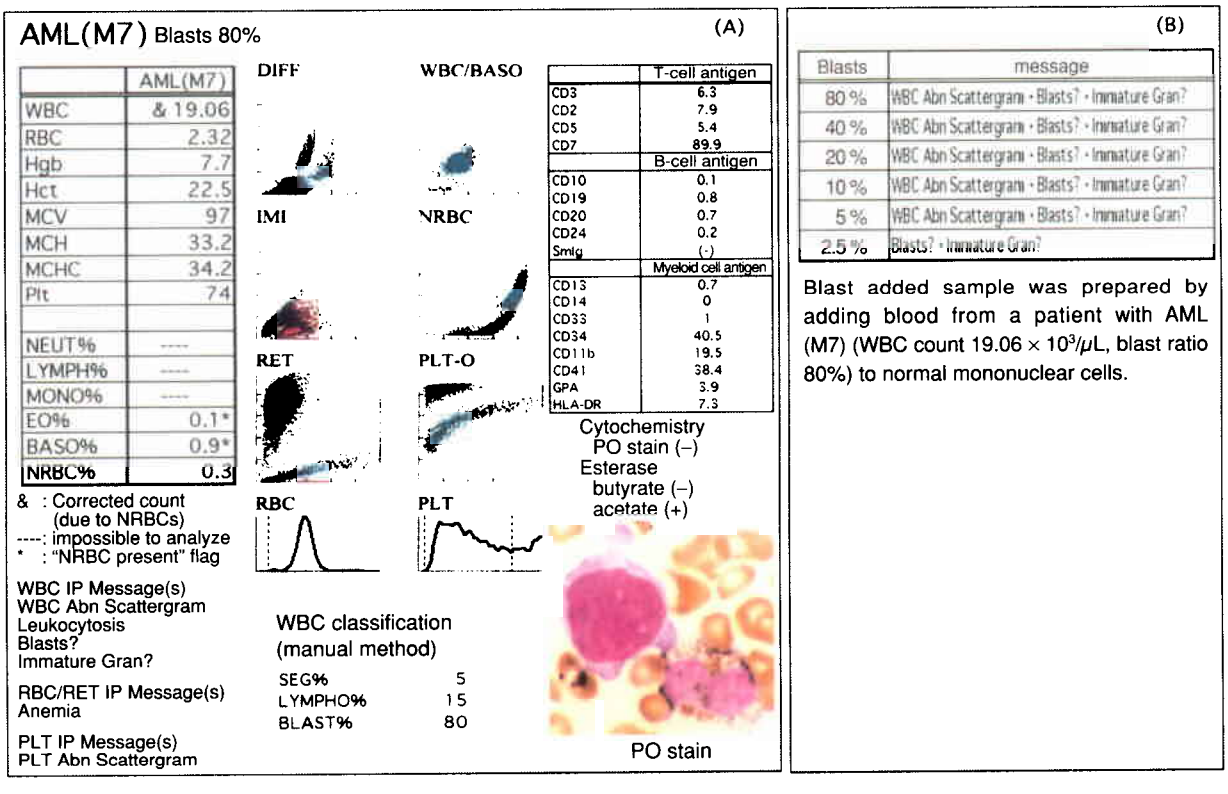


Fig. 4 *A) Test results, scattergrams and messages of XE-2100 in AML (M7) and*
B) Evaluation of WBC messages

Detection ability for blast cells

Flagging performance in ALL (L1), AML (M2) and chronic granulocytic leukemia (CGL)

Fig. 3 shows DIFF, WBC/BASO and IMI channel scattergrams obtained from patients with ALL (L1), AML (M2), and CGL. Each was accompanied by a "Blast" flag. The areas where neoplastic cells appear are enclosed within a red gate. The corresponding photomicrograph is displayed for each patient. The "&" mark added to WBC counts implied correction of WBC counts for NRBC, and the "@" mark an indicator for "out of range of assurance" for linearity. The DIFF scattergrams of ALL and AML are displayed in the grey color, indicating that the classification of cells was impossible. However, the message correctly reflected the existence of blast cells. In the CGL patient's DIFF scattergram the major increases in band cells, metamyelocytes and myelocytes are accurately reflected by the distribution shape of blue-colored area (NEUT). The IMI scattergrams in the CGL and AML (M2) patients are not dissimilar, however, in the latter there is a hint of two distinct populations suggesting an hiatus leukemicus. The CGL scattergram is of a single population but suggesting a serial and successive differentiating process. These scattergram accurately reflected the morphology findings on microscopy of the blood films.

Detection ability for blast cells when diluted with normal mononuclear cells

The AML sample (M7 : Blast ratio 80%) was mixed with normal mononuclear cells sample at the ratios indicated (***Fig. 4 (B)***), and the sensitivity of the XE-2100 was examined.

In this experiment the XE-2100 generated a "Suspect" message until the blasts reached a level of 2.5%. At that level the Q-Flag display suggested a confidence of "Blasts?" flagging of 80% (Re-calculated using the maximum value 300 of Q-Flag as 100%, *e.g.* when the original Q-Flag grade value was 240, the confidence level became $240/300 \times 100 = 80$ (%)).

The index case was an AML (M7) with 80% blast cells. The morphology and immunophenotyping results are summarized in ***Fig. 4***. In the assay results with XE-2100, the WBC values were displayed with "&" mark and the WBC counts were corrected for the appearance of NRBC. The message of "impossible to analyze (----)" in NEUT, LYMPH and MONO cells and the message of "decrease in confidence (*)" in BASO and EO cells were displayed after classification. In addition, WBC suspect messages were displayed: "WBC ABN Scattergram, Blasts?, Immature Gran?"

Flagging performance in selected patients (see Cases section in Materials and Methods)

Table 2 summarizes the values determined by manual differential and by the XE-2100.

Case 1 is a mixed leukemia which, on microscopy, revealed lymphoblastoid (myeloperoxidase negative) cells (61%). The XE-2100 generated "At-Ly?" and "Abn-Ly/L-Bl?" flags.

Cases 2 to 5 (***Table 2***) demonstrated 1 - 21% myeloblasts on visual microscopy. In each, the XE-2100 produced a suspect flag for "Blasts?"

Three cases with ATL (6 to 8) were classified by manual differential as containing 77, 8 and 23% Ab-lymph, respectively. The XE-2100 displayed "Abn-Ly/L-Bl?" in cases 6 and 7 and "Blasts?" in case 8.

Both cases 10 and 15 revealed very low atypical lymphocyte counts (1 %) and small numbers of immature granulocytes (2% and 4%). In these specimens the XE-2100 produced "IG?" flags but no "At-Ly?" flag.

The XE-2100 displayed "IG?" in all cases possessing immature granulocytes on manual differential (cases 2, 3, 4, 5, 10, 11, 12, 15 and 17).

Excellent agreement between NRBC counts by manual differential and the XE-2100 was observed in all cases studied (3, 11, 15 and 16).

Usefulness of flagging in lymphoid tumors

Fig. 5 and ***Table 3*** show the DIFF scattergram of mature type lymphoid tumor and the messages generated, respectively. When examining ATL cases on the DIFF scattergram, it was noted that the population of neoplastic cells was distributed either in a vertical array (***Fig. 5*** a, d) or in a broader, more horizontal array (***Fig. 5*** b, c, e).

In the 5 cases of ATL cited in ***Table 3***, the longitudinal pattern corresponded to the manual differential features of a more acute type of ATL and the horizontal pattern with a more chronic variety. Differentiation of the different lymphoid tumors (ATL, CLL and HCL-V) was, however, not possible. Smoldering ATL or large granular lymphocytic leukemia (LGLL) where only few abnormal lymphocytes like normal lymphocytes appeared could not necessarily be detected. These have been occasionally classified into the normal category.

In 4 of 5 patients with ATL (***Table 3*** cases 19-22) the XE-2100 displayed "Abn-Ly/L-Bl?". Concordance with Q-Flag grading confidence levels was high ranging from 70 - 100% (see Detection of Neoplastic Cells , Section 2 and ***Table 3***). Case 18 was a more acute type in which manual differential revealed blast-like cells. In this specimen the XE-2100 displayed "Blast?". On the other hand, the XE-2100 did not display any abnormal message for LGLL. (***Table 3*** Case 25). In a viral infection (***Table 3***, Case 27) the XE-2100 displayed both "Aty Lymph?" and "Abn-Ly/L-Bl?" messages. These anomalies remain a developmental problem for the future.

Correlation between PLT-I and PLT-O on XE-2100 where there existed a difference in platelet count on current analyzers

*The influence of megathrombocytes: This was particularly obvious in a single patient with AML and tri-lineage dysplasia (**Fig. 6**).*

The case was a male patient aged 68 years suffering from tri-lineage dysplasia.

When determining WBC counts by the K-2000, NE-8000 and XE-2100, very different results (11.5, 6.1 and $1.9 \times 10^3/\mu L$, respectively) were obtained. Manual differential revealed a remarkable decrease in the total WBC count and a large number of megathrombocytes (***Fig. 6***). The WBC histogram from the NE-8000 showed a pseudo-increase in lymphocytes but clearly this was due to the presence of megathrombocytes. As the patient responded to treatment and the megathrombocyte concentration decreased, the WBC anomalies disappeared. Throughout,

Table 2 *WBC IP Message (s) in the cases with morphological abnormality by manual differential*

No	Disease	WBC	Manual differential (100 count)													Flag (XE-2100)						
		(×10³/μL)	blast	pro	myelo	meta	stab	seg	ly	mo	eo	ba	At-ly	Ab-ly	NRBC	WBC-A-S	Bl ?	IG ?	LS ?	At-Ly ?	Abn-Ly/L-Bl ?	NR%
1	Mixed Leukemia	5.1	61	0	0	0	2	1	36	0	0	0	0	0	0			◎(33%)		◎(100%)	◎(100%)	0
2	CGL crisis	28.0	21	0	4	3	14	10	32	16	0	0	0	0	1		◎(100%)	◎(100%)	◎(37%)			0
3	Myelofibrosis	8.4	3	1	6	1	18	38	21	1	4	6	1	0	4		◎(40%)	◎(100%)	◎(90%)			5.2
4	MPD	45.5	1	1	0	2	5	87	3	0	0	1	0	0	0	◎	◎(100%)	◎(100%)	◎(60%)			0.3
5	NHL	8.7	1	0	1	0	23	53	9	10	2	0	1	0	0		◎(43%)	◎(50%)				0
6	ATL	30.1	0	0	0	0	0	15	7	1	0	0	0	77	0	◎		◎(40%)			◎(100%)	1.8
7	ATL	9.1	0	0	0	0	4	38	41	7	2	0	0	8	0					◎(33%)	◎(100%)	0
8	ATL	15.8	0	0	0	0	0	38	31	7	1	0	0	23	0		◎(67%)	◎(77%)				0
9	CLL	21.6	0	0	0	0	0	9	0	3	2	0	0	96	0	◎				◎(100%)	◎(100%)	0
10	Myeloma	7.2	0	0	1	1	0	59	16	0	3	19	1	0	0			◎(37%)				0
11	Anemia	14.4	0	0	0	2	3	31	59	5	0	0	0	0	12	◎		◎(97%)				28.4
12	ITP	12.0	0	0	1	1	2	50	44	2	0	0	0	0	0			◎(60%)				0
13	Toxic erythema	9.6	0	0	0	0	1	8	77	2	1	0	11	0	0					◎(100%)	◎(100%)	0
14	Pneumonia	7.4	0	0	1	0	4	48	38	6	2	1	0	0	0							0
15	Malignant tumor	3.8	0	0	0	4	14	45	12	15	0	0	1	0	15			◎(100%)	◎(53%)			11.5
16	Ovarian cancer	4.4	0	0	0	0	10	70	12	8	0	0	0	0	2			◎(97%)	◎(90%)			2.7
17	Pulmonary cancer, bone metastases	8.5	0	1	4	0	14	35	31	14	1	0	0	0	0			◎(100%)	◎(60%)			0

WBC IP Message(s)	
WBC-A-S	WBC Abn Scattergram
Bl ?	Blasts ?
IG ?	Immature Gran ?
LS ?	Left Shift ?
At-Ly ?	Aty Lymph ?
Abn-Ly/L-Bl ?	Abn Lymph/L-Blasts ?
NR%	NRBC%

Table 3 *Clinical laboratory data and WBC IP messages (s) and its levels on chronic lymphoid leukemias and viral infection*

No	Disease	WBC	Manual differential			Flag (XE-2100)					
			Ab-Lymph	At-Lymph	Lymph	WBC Abn Scattergrm	Aty Lymph ?	Blasts ?	Immature Gran ?	Left Shift ?	Abn Lymph /L-Blasts ?
18	ATL(a)	35.8*	88%		1%	◎		◎(100%)	◎(100%)	◎(40%)	
19	ATL(b)	34.3	80%		13%						◎(70%)
20	ATL(c)	8.6	54%		34%		◎(100%)				◎(77%)
21	ATL(d)	20.6	49%		31%	◎					◎(100%)
22	ATL(e)	14.0	56%		32%						◎(90%)
23	CLL	24.6	90%								◎(100%)
24	HCL-V	112.5@	97%			◎	◎(100%)		◎(93%)		◎(100%)
25	LGLL	5.8	75%		5%						
26	Leukemic manifestation of NHL	8.7	2%		6%		◎(100%)		◎(80%)		◎(53%)
27	Viral infection	14.8		3%	65%		◎(100%)				◎(100%)

the XE-2100 accurately differentiated megathrombocytes from WBC and consistently provided a correct fluorescence platelet count.

*RBC fragments in a patient with MDS transforming into AML (complicated by disseminated intravascular coagulation {DIC} **Fig. 7**).*

The case is a female patient aged 69 years. She is transforming from MDS to AML with platelet counts of 186 and 246 × $10^3/\mu L$ by the K-4500 and NE-8000, respectively. When measured on the XE-2100, the platelet count was 17 × $10^3/\mu L$, agreeing well with manual differential (15 × $10^3/\mu L$). Because of the RBC flagments the abnormal platelet volume distribution triggered the switching algorithm of the counting method and the optical platelet count was displayed.

These two cases indicate that the sheath flow impedance method was incapable of distinguishing megathrombocytes and RBC fragments from platelets, although the anomalies were flagged on the PLT histogram.

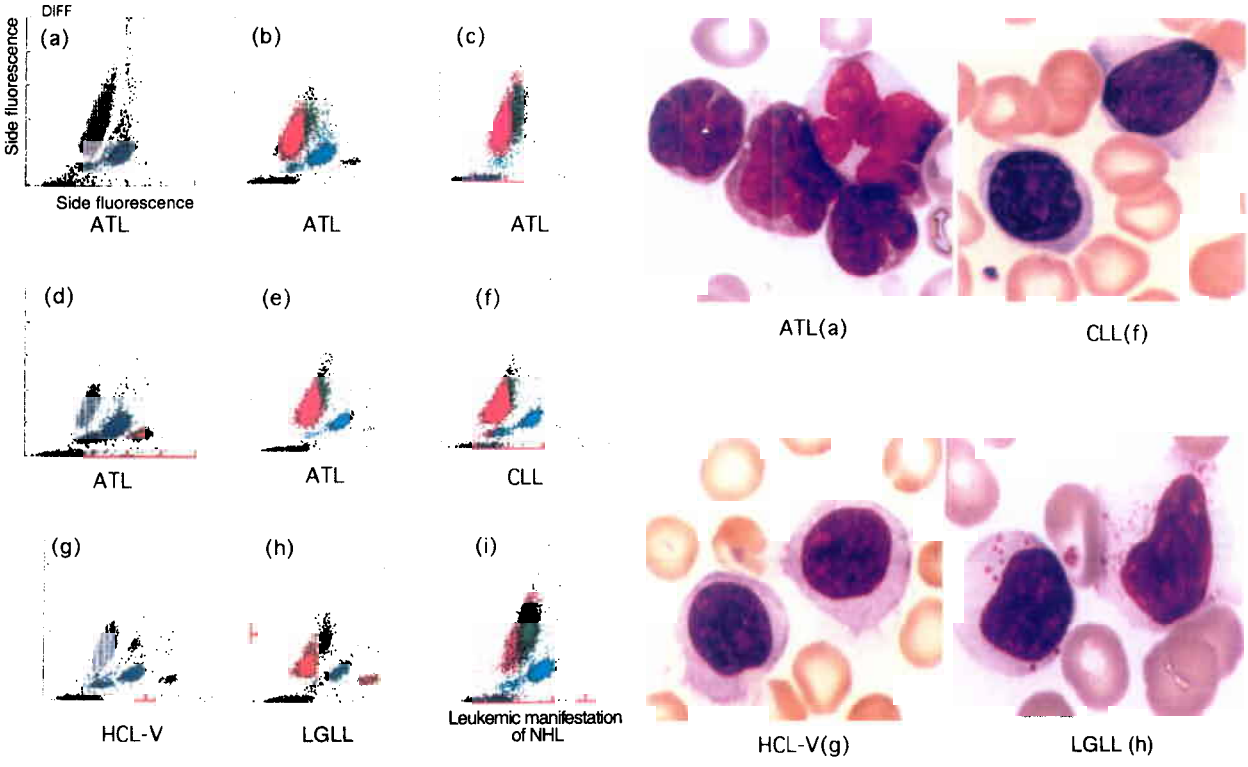
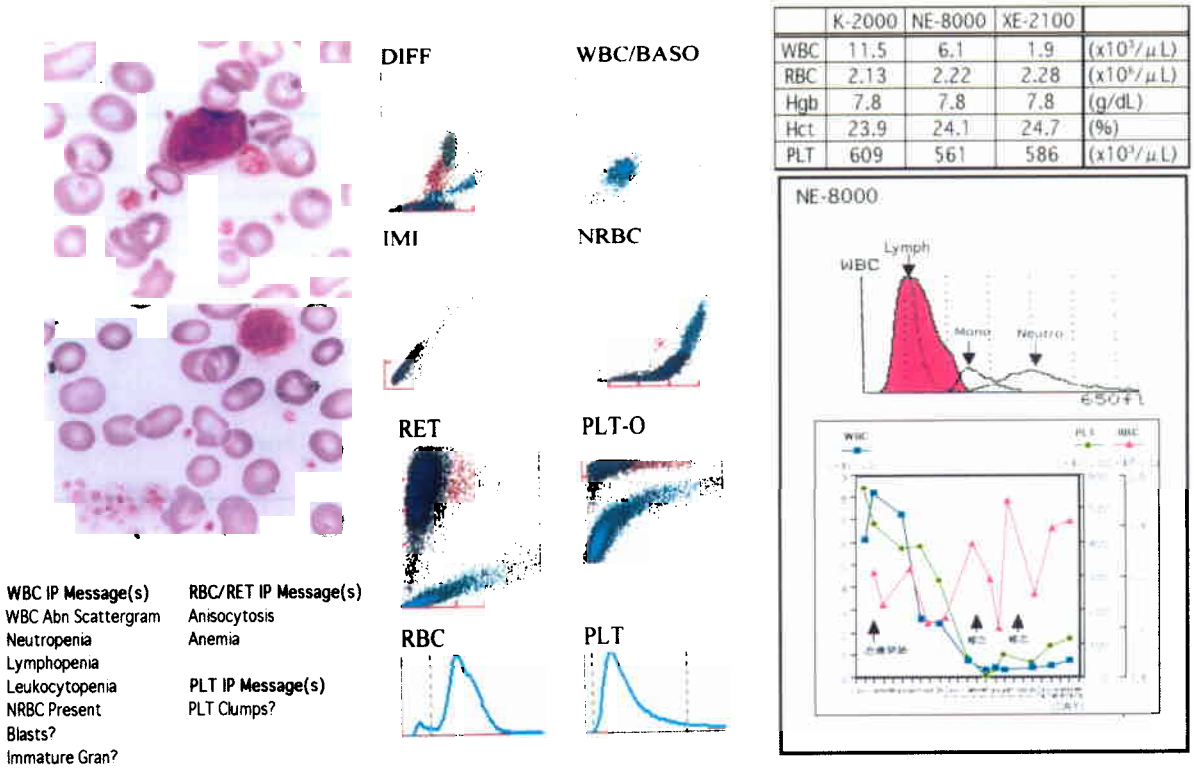
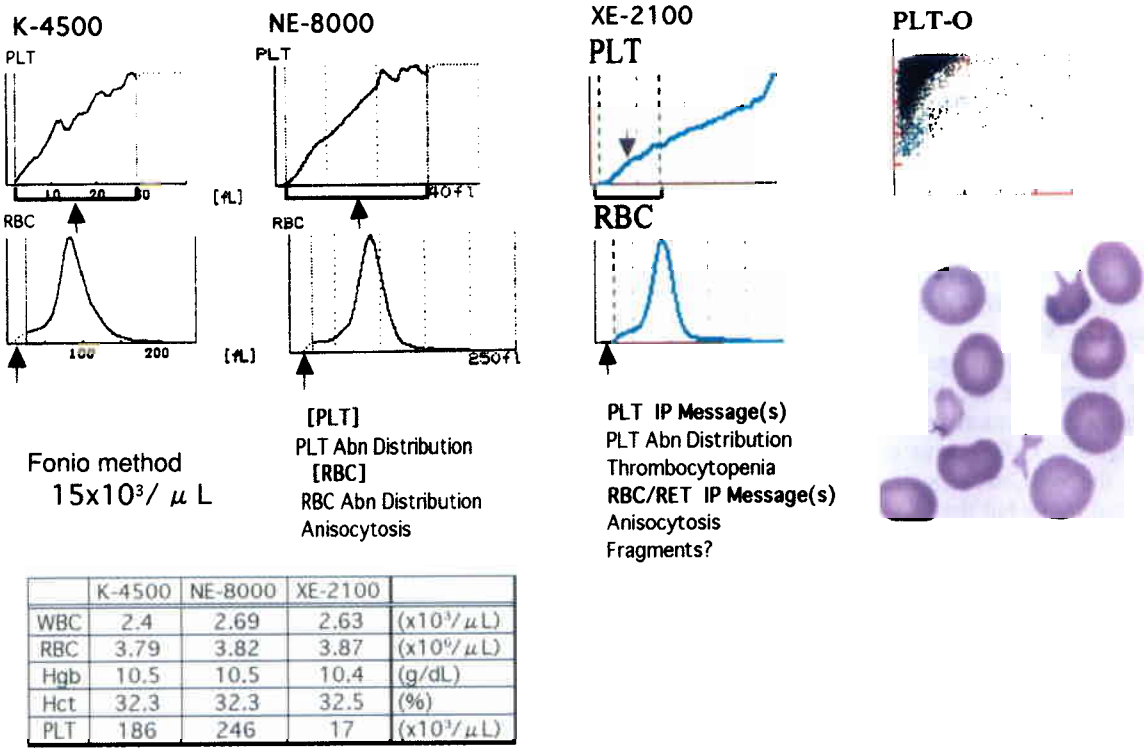


Fig. 5 Comparison between DIFF scattergrams and morphological images on chronic lymphoid leukemias



	K-2000	NE-8000	XE-2100	
WBC	11.5	6.1	1.9	($\times 10^3/\mu L$)
RBC	2.13	2.22	2.28	($\times 10^6/\mu L$)
Hgb	7.8	7.8	7.8	(g/dL)
Hct	23.9	24.1	24.7	(%)
PLT	609	561	586	($\times 10^3/\mu L$)

Fig. 6 AML / TLD patient with megathrombocytes. Note the different WBC counts on some analyzers due to the presence of megathrombocytes. XE-2100 gives the correct WBC count.



	K-4500	NE-8000	XE-2100	
WBC	2.4	2.69	2.63	(x10³/μL)
RBC	3.79	3.82	3.87	(x10⁶/μL)
Hgb	10.5	10.5	10.4	(g/dL)
Hct	32.3	32.3	32.5	(%)
PLT	186	246	17	(x10³/μL)

Fig. 7 *Shifting case from MDS to AML observed differences in platelet counts due to the appearance of RBC fragment cells among the analyzers*

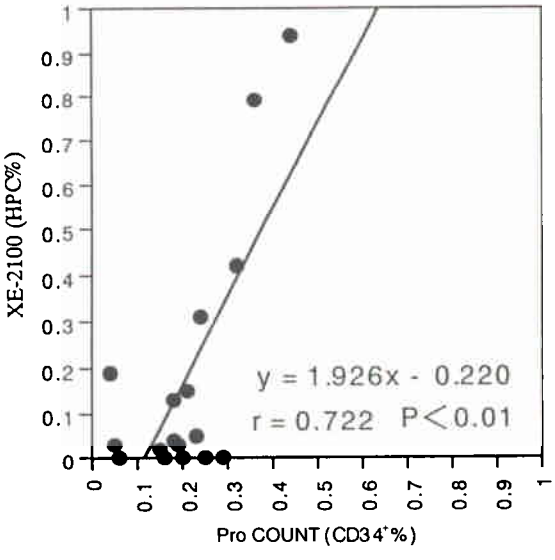


Fig. 8 *Correlation between HPC% generated by the XE-2100 and CD34⁺% by conventional flow cytometry*

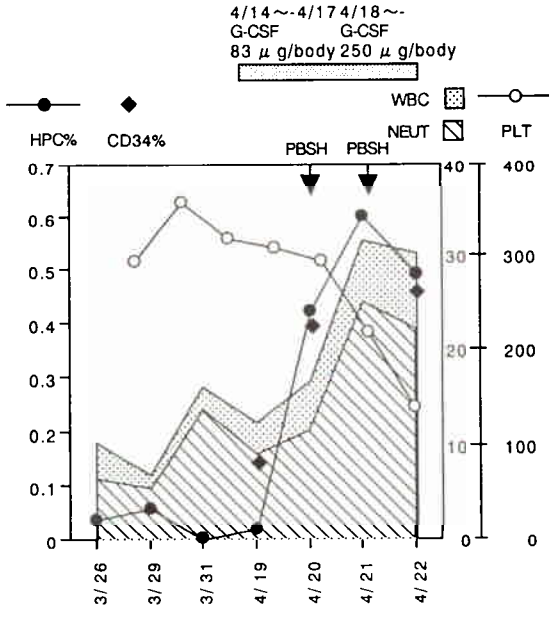


Fig. 9 *A patient with malignant lymphoma after chemotherapy Trends over time in WBC (NEUT), platelet count, HPC% and CD34⁺ following stem cell mobilization by G-CSF.*

Evaluation of the usefulness of the HPC count prior to stem cell harvesting

Correlation between the HPC% by the XE-2100 and CD34⁺% by conventional flow cytometry

Fig. 8 shows the comparion between HPC% and CD34⁺%. The correlation linearity was y = 1.926 – 0.22 and the correlation coefficient r = 0.722, ($p < 0.01$). HPC% tended to be higher than CD34⁺% by a factor of 1.5 – 2. It has been confirmed that CD34 positive cells are included in the HPC% fraction.

*Behaviour of WBC (NEUT) and platelet counts, CD34⁺ assay and HPC during mobilization therapy (**Fig. 9**)*

The case is male patient aged 42 years. This patient has malignant lymphoma and the blood picture following a second course of chemotherapy is shown (3/26,3/29 and 3/31 in ***Fig. 9***). G-CSF was commenced on 4/19 at a time when the WBC was elevated and the platelet count in the normal range but the HPC was very low at 0.02%. Immediately following the start of G-CSF (4/19) a dramatic increase in the HPC% occurred (to 0.42% on 4/20 and 0.60% on 4/21). The CD34⁺ response mirrored HPC behavior (0.15% on 4/19, 0.39 on 4/20 and 0.48% on 4/22). Clearly, in this patient HPC% correlated well with CD34⁺. These results confirm the clinical utility of HPC%.

CONCLUSION

In this study, the reproducibility for all measured parameters was impressive. The ability to correct the total and differential WBC count in the presence of NRBC and to count those NRBCs is new and appears to function well. The algorithm driven alternative platelet technologies improve the functionality of the analyzer when there is an abnormal platelet volume distribution or when a very low count exists.

The messages generated by abnormal specimens reflected particular clinical patterns. The concordance between the presence of blast cells in the peripheral blood and the "Blast?" message was impressive. The HPC assay closely parallels (but does not equal) the CD34⁺ assays. The CD34⁺ assay is expensive, requires flow cytometry expertise and is time consuming. The HPC assay, on the other hand, is performed rapidly by a routine hematology analyzer. The only ability required is that of operating the XE-2100 correctly and efficiently. Because of the advanced data handling, storage and retrieval capability of the analyzer, it is anticipated that the XE-2100 will enhance both the smooth running of the laboratory and the hematology information necessary for modern patient care.

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