Evaluation of the CS-5100 Automated Blood Coagulation Analyzer

Osamu SEKI, Chie SUZUKI, Asami SASAKI, Yukiko KUWASHIMA, Aya SATOU, Mitsuaki NAGASAWA and Mitsuko KAKU

Department of Clinical Laboratory, Tohoku University Hospital, 1-1 Seiryo-machi, Aoba-ku, Sendai 980-8574, Japan

Measurement accuracy and high throughput are both expected and required in fully automated blood coagulation analyzers. We performed basic examinations of the CS-5100 automated blood coagulation analyzer (CS-5100; Sysmex Corporation, Kobe, Japan). Within-run reproducibility and between-run reproducibility were good, and analysis interference from Hemolysis, Icterus and Lipemia was not observed. PT activity values were slightly lower with Thromboel® S, and D-dimer values were relatively higher with LIAS AUTO D-Dimer NEO in the CS-5100 compared to the blood coagulation analyzer Coapresta® 2000 (CP2000; SEKISUI MEDICAL Co., Ltd., Tokyo, Japan). We determined these differences were due to differences in reagent formulation. Turnaround time (TAT), the time required from analysis to report, was shortened in the CS-5100, from 31 minutes to 17 minutes compared to the CP2000. In conclusion, the CS-5100 is excellent in making prompt and precise reporting and useful in daily use for analyzing large number of specimens.

Key Words CS-5100, TAT

INTRODUCTION

Reduction of time to reporting is essential for diagnostic testing. Therefore, improvement of throughput is required in automated analyzers, in addition to improvement in analysis accuracy [1].

The fully automated blood coagulation analyzer CS-5100 (CS-5100; Sysmex Corporation, Kobe, Japan) is capable of analysis by four different methodologies: clotting, chromogenic, immunoturbidimetric and aggregation. It has 20 photometric units that employ multi-wavelength detection. Therefore, irrespective of the analysis parameters ordered, all the detectors of the analyzer can handle the clotting, chromogenic and immunoturbidimetric assays. Thus, up to 400 tests per hour is possible even when a parameter that uses the chromogenic assay or immunoturbidimetric assay is also ordered [2,3]. In addition to this, the time and effort involved in opening the caps of blood collection tubes is now eliminated because of the cap-piercing function. Use of the cap-piercing function is an ergonomic improvement that contributes greatly to prevention of infection [3].

This reports the results of our comparison study of the CS-5100 undertaken when we changed testing platforms.

SPECIMENS, ANALYZERS AND REAGENTS

1. Specimens

We used blood samples of hospitalized patients and outpatients of our hospital sent to the laboratory for coagulation testing.

2. Analyzers and reagents

The CS-5100 analyzer was evaluated. We used the coagulation analyzer Coapresta® 2000 (CP2000; SEKISUI MEDICAL Co., Ltd., Tokyo, Japan) as the predicate analyzer to study the correlation of analysis results.

The 11 analysis parameters studied were prothrombin time (PT), activated partial thromboplastin time (APTT), fibrinogen (FBG), thrombotest (TT), hepaplastin test (HPT), antithrombin III (AT), plasminogen (PLG), α2-antiplasmin (APL), fibrin/fibrinogen degradation products (FDP), D-dimer (DD) and fibrin monomer (FM). The reagents used in the study with the CS-5100 and the predicate analyzer CP2000 are listed in ***Table 1***.

Note: This article is translated and republished from the Sysmex Journal Web Vol. 15 No. 1, 2014.

Table 1 *Reagents used*

	Measurement principle	Reagent used in test	Supplier	Conventional reagent	Supplier
PT	Clotting assays	Thromborel® S	Sysmex	Thrombocheck PT Plus	Sekisui Medical
		Dade® Innovin®			
APTT		Thrombocheck APTT		Thrombocheck APTT	
		Thrombocheck APTT-SLA			
FBG		Thrombocheck Fib (L)		Thrombocheck Fib (L)	
TT		Compound factor T Kokusai Blue		Compound factor T Kokusai	
HPT		Compound factor H Kokusai		Compound factor H Kokusai	
AT	Chromogenic assays	L System-AT III		Testzym® S AT III	
PLG		L System-PLG		Testzym® S PLG	
APL		L System-APL		Testzym® S APL	
FDP	Immunoturbidimetric assays	Latex Test BL-2 P-FDP		Nanopia® P-FDP	
DD		LIAS AUTO D-Dimer NEO		Nanopia® D-dimer	
FM		Auto LIA FM		Auto LIA® FM	Roche

METHODS

1. Within-run reproducibility

Ten replicate measurements were made on pooled plasmas of two concentrations.

2. Between-run reproducibility

Over a period of four days, PT, APTT, FBG, TT, HPT, AT, APL and PLG were measured using Coagutrol IX and IIX, FDP and DD using FDP CONTROL NEO and D-Dimer CONTROL NEO, and FM using LIA FM Control (all from Sysmex Corporation).

3. Influence of interfering substances

The effect of hemoglobin, conjugated bilirubin, free bilirubin and lipemia were investigated using Interference Check A Plus (Sysmex Corporation).

4. Correlation with the predicate method

Correlation between analysis results of patients' samples obtained with the CS-5100 and the CP2000 was examined.

5. Comparison of TAT

The average turnaround time (TAT) of 539 samples assayed by the CS-5100 was compared with that of 605 assayed by the CP2000. These samples had been received from 8 AM to 1 PM during the five days of December 17 - 21, 2012 and July 22 - 26, 2013 respectively for the CP2000 and the CS-5100. In both cases the TAT was measured from the time of receiving the centrifuged samples to reporting of the final results.

RESULTS

1. Within-run reproducibility

The CV was 0.22 - 1.54%, 0.72 - 4.80% and 0.70 - 6.14% respectively for parameters measured by the clotting, chromogenic and immunoturbidimetric assays (***Table 2***).

2. Between-run reproducibility

The CV was 0.34 - 7.21%, 1.21 - 5.02% and 2.22 - 7.37% respectively for parameters measured by the clotting, chromogenic and immunoturbidimetric assays (***Table 3***).

3. Influence of interfering substances

The investigation using Interference Check A Plus showed no effect of hemoglobin, conjugated bilirubin, free bilirubin, or lipemia on any of the analysis parameters (***Fig. 1-A*** and ***Fig. 1-B***).

4. Correlation with the predicate method

The correlation coefficient was satisfactory at 0.94 - 0.99 for all the analysis parameters except APL measured using L System, which showed a correlation coefficient of 0.89. Compared to Thrombocheck PT Plus, the reagent that was in use, the PT% tended to be lower with Thromborel® S (y=0.77x+3.35). Also, the D-dimer values obtained with LIAS AUTO D-Dimer NEO tended to be higher than with the previously used Nanopia® D-dimer (y=1.46x - 0.18) (***Fig. 2***).

Table 2 *Within-run reproducibility*

Reagent	Unit		Mean	SD	CV (%)	Max	Min
Thromborel® S	%	sample 1	79.3	0.94	1.19	80.0	77.4
		sample 2	37.1	0.26	0.71	37.6	36.8
Dade® Innovin®	%	sample 1	123.2	1.90	1.54	126.1	120.4
		sample 2	55.8	0.28	0.51	55.9	55.0
Thrombocheck APTT	sec	sample 1	31.4	0.07	0.22	31.5	31.3
		sample 2	54.0	0.24	0.44	54.4	53.6
Thrombocheck APTT-SLA	sec	sample 1	33.3	0.12	0.36	33.4	33.1
		sample 2	70.8	0.22	0.31	71.2	70.5
Thrombocheck Fib (L)	mg/dL	sample 1	318.9	4.51	1.41	323.7	311.1
		sample 2	113.5	1.29	1.13	115.6	111.5
Compound factor T Kokusai Blue	%	sample 1	120.7	0.85	0.71	121.8	119.5
		sample 2	46.5	0.16	0.35	46.8	46.2
Compound factor H Kokusai	%	sample 1	140.3	0.77	0.55	141.2	139.7
		sample 2	52.2	0.49	0.95	52.7	51.3
L System-AT III	%	sample 1	74.9	1.87	2.49	78.1	72.0
		sample 2	38.3	1.20	3.14	40.2	36.6
L System-PLG	%	sample 1	93.8	0.68	0.72	94.5	92.5
		sample 2	46.3	0.61	1.32	47.5	45.5
L System-APL	%	sample 1	102.7	3.90	3.80	106.5	94.7
		sample 2	45.4	2.18	4.80	48.8	41.6
Latex Test BL-2 P-FDP	µg/mL	sample 1	13.8	0.31	2.25	14.3	13.4
		sample 2	43.4	0.30	0.70	43.9	43.0
LIAS AUTO D-Dimer NEO	µg/mL	sample 1	6.1	0.14	2.24	6.2	5.8
		sample 2	90.4	0.99	1.10	91.8	88.1
Auto LIA FM	µg/mL	sample 1	4.7	0.29	6.14	5.3	4.5
		sample 2	138.7	1.97	1.42	140.8	134.4

Table 3 *Between-run reproducibility*

Reagent	Unit		Mean	SD	CV (%)	Max	Min
Thromborel® S	%	sample 1	85.3	3.67	4.31	90.1	81.3
		sample 2	38.0	2.74	7.21	40.7	34.7
Dade® Innovin®	%	sample 1	97.4	1.71	1.76	99.5	95.3
		sample 2	37.4	0.46	1.22	37.9	36.8
Thrombocheck APTT	sec	sample 1	28.4	0.22	0.78	28.7	28.2
		sample 2	63.4	0.83	1.32	64.2	62.3
Thrombocheck APTT-SLA	sec	sample 1	29.5	0.10	0.34	29.6	29.4
		sample 2	99.0	1.75	1.76	100.2	96.5
Thrombocheck Fib (L)	mg/dL	sample 1	295.0	10.87	3.68	305.7	280.3
		sample 2	132.9	4.24	3.19	135.8	126.8
Compound factor T Kokusai Blue	%	sample 1	106.0	5.45	5.14	110.8	98.4
		sample 2	39.2	1.67	4.28	41.0	37.6
Compound factor H Kokusai	%	sample 1	98.3	5.50	5.59	105.9	91.8
		sample 2	36.1	2.20	6.10	38.6	33.3
L System-AT III	%	sample 1	98.8	1.71	1.73	101.0	97.3
		sample 2	29.5	1.29	4.38	31.2	28.4
L System-PLG	%	sample 1	104.3	1.26	1.21	106.3	103.4
		sample 2	34.5	1.73	5.02	36.8	32.1
L System-APL	%	sample 1	112.0	1.83	1.63	114.8	110.8
		sample 2	48.0	1.41	2.95	49.0	46.1
Latex Test BL-2 P-FDP	µg/mL	sample 1	7.1	0.52	7.37	7.7	6.5
		sample 2	26.7	0.59	2.22	27.1	25.8
LIAS AUTO D-Dimer NEO	µg/mL	sample 1	1.5	0.06	3.98	1.5	1.4
		sample 2	8.7	0.25	2.88	8.8	8.3
Auto LIA FM	µg/mL	sample 1	13.9	0.64	4.59	14.4	13.3
		sample 2	80.1	2.57	3.21	83.0	76.9

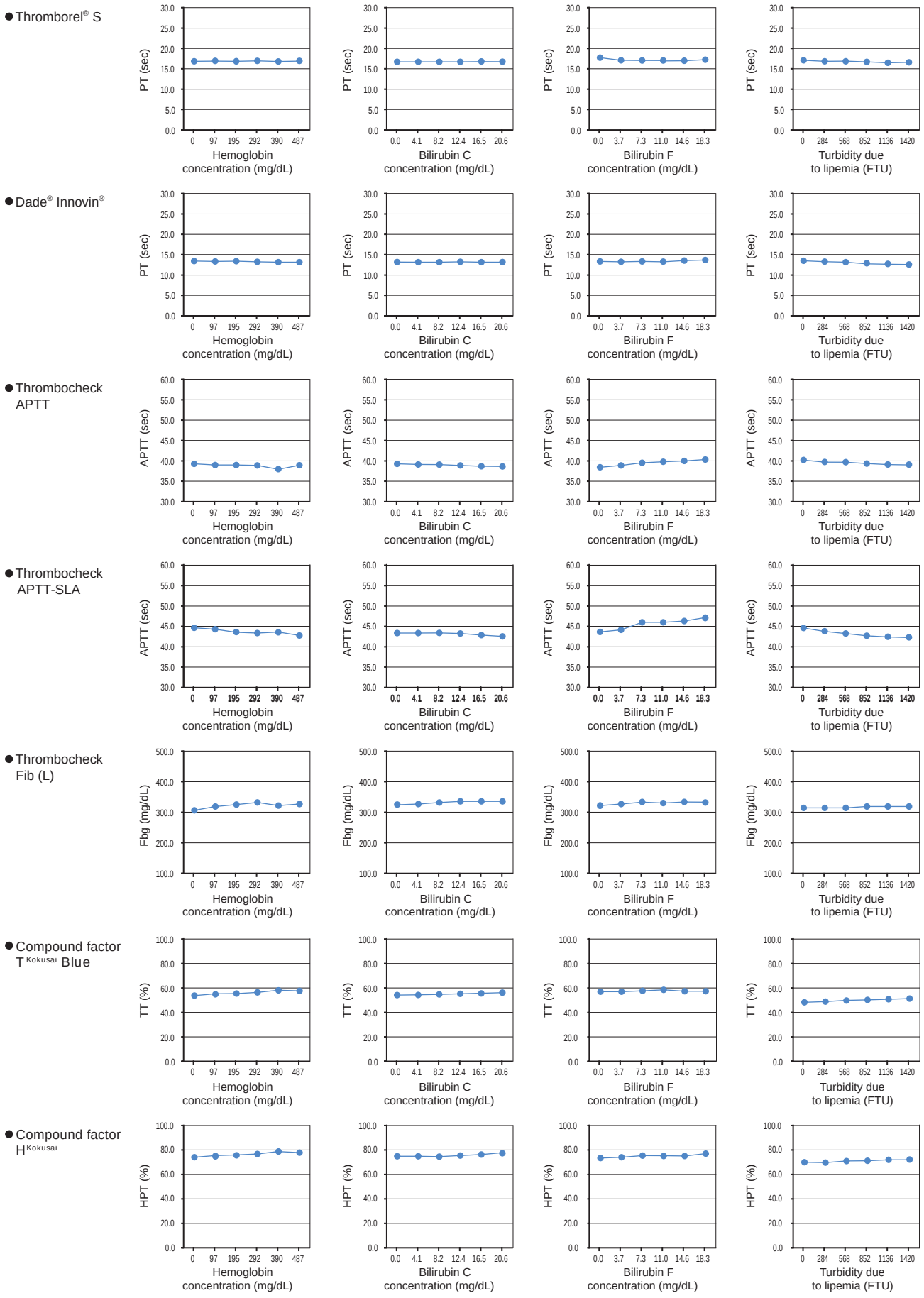

Fig. 1-A *Influence of common interfering substances*

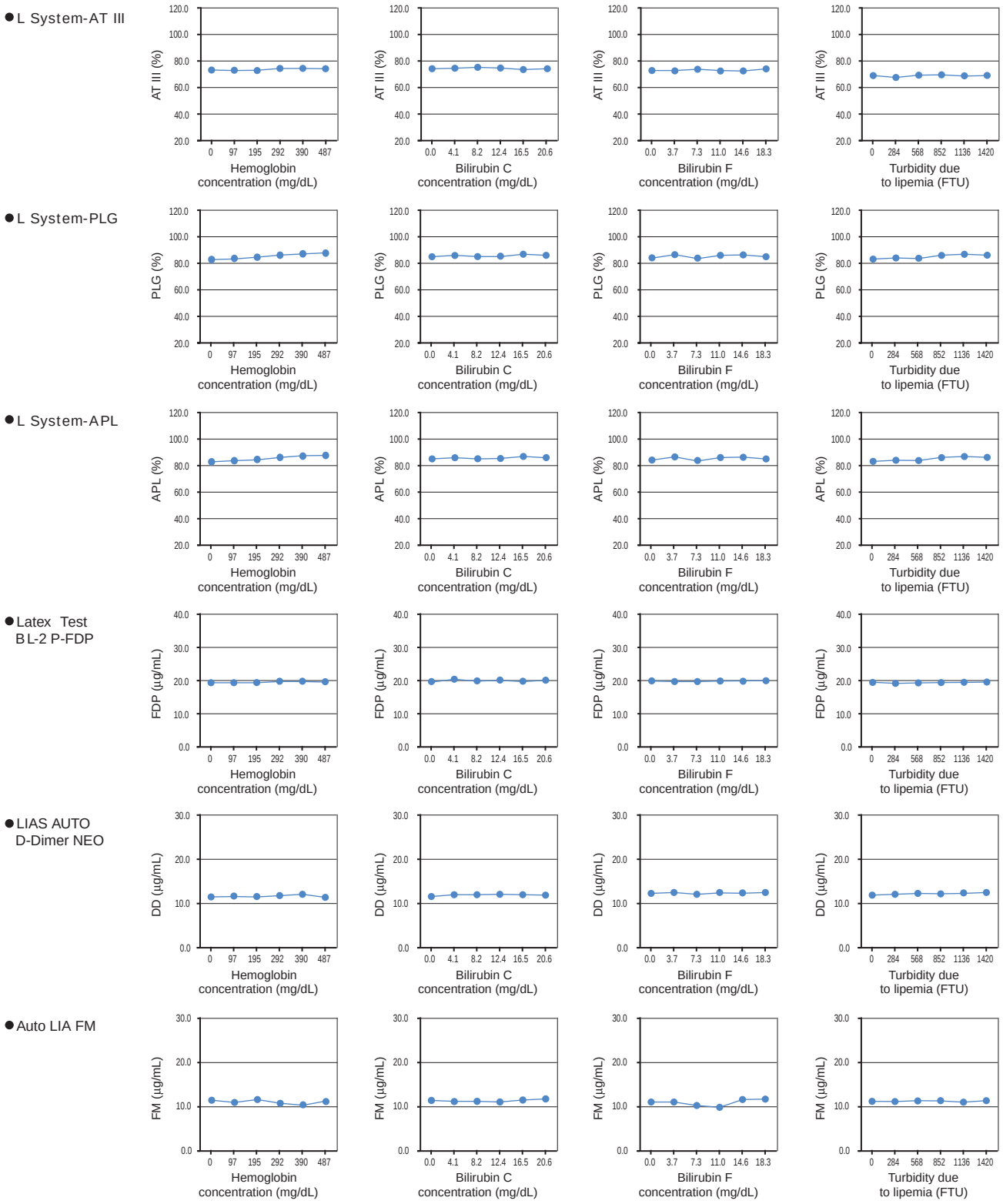

Fig. 1-B *Influence of common interfering substances*

5. Comparison of TAT

TAT for different times of sample receipt is shown in ***Fig. 3***. The mean TAT was 31 minutes with the CP2000, and it was shortened to 17 minutes with the CS-5100. Using the CP2000, a fairly large number of samples had TAT more than 60 minutes, some exceeding even 90 minutes. When using the CS-5100, however, the analysis report was ready within about 30 minutes for almost all samples.

Fig. 4 shows the percentages and numbers of analysis reports stratified according to TAT. With the CP2000, 37% of the samples' TAT was within 10 minutes, and 79% within 30 minutes, whereas with the CS-5100, 74%

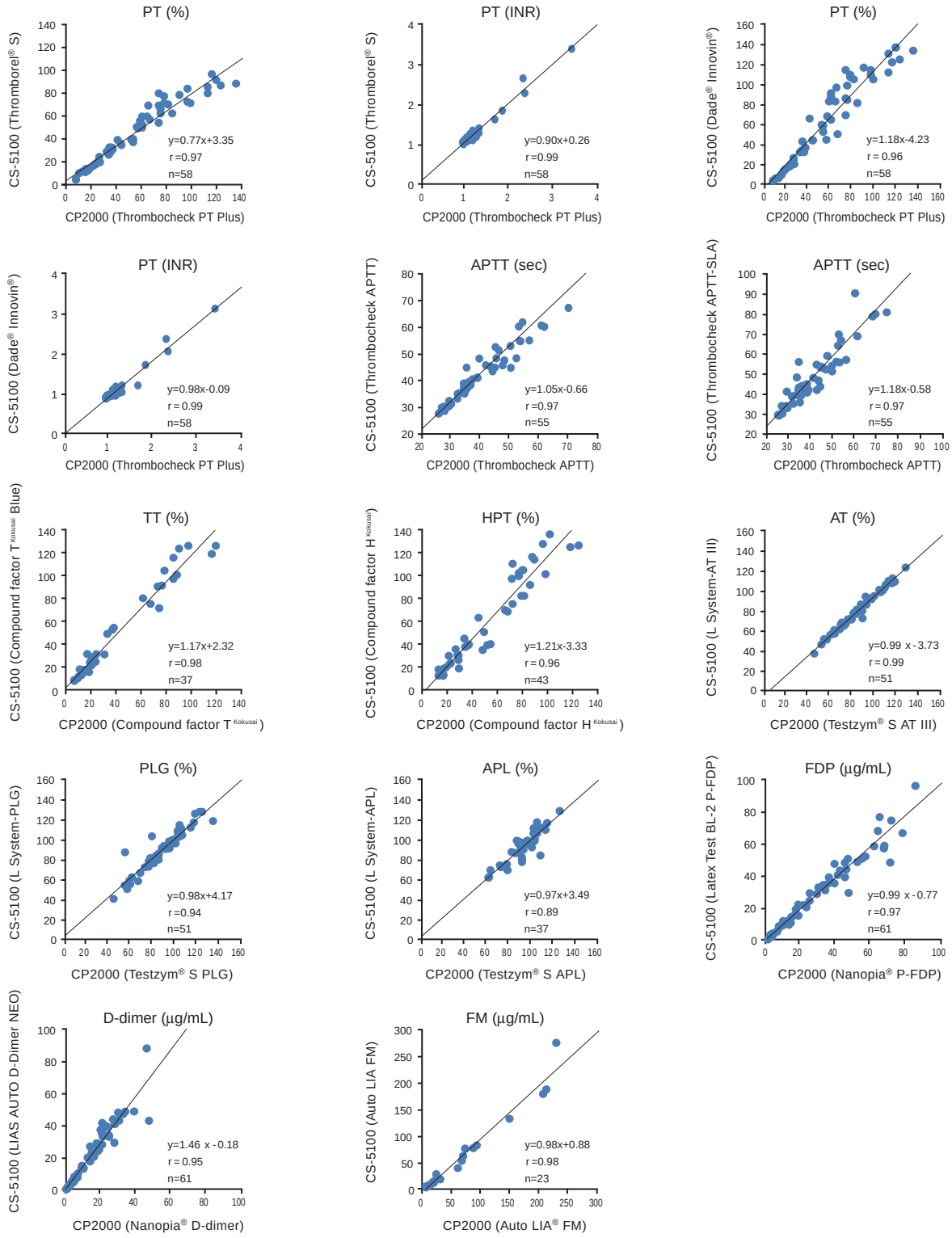

Fig. 2 *Correlation of CS-5100 with the predicate method*

of the samples were ready to be reported within 10 minutes, and 94% within 30 minutes.

DISCUSSION

Our examination of the basic performance of the CS-5100 showed good within-run and between-run reproducibility. Moreover, with all the analysis parameters, there was no interference caused by substances such as hemoglobin, conjugated bilirubin, free bilirubin and lipemia.

There was good correlation (correlation coefficient 0.89 - 0.99) between the results obtained with the CS-5100 and CP2000. In the evaluation of the CS-5100, we used Thromborel® S which contains human placenta-origin

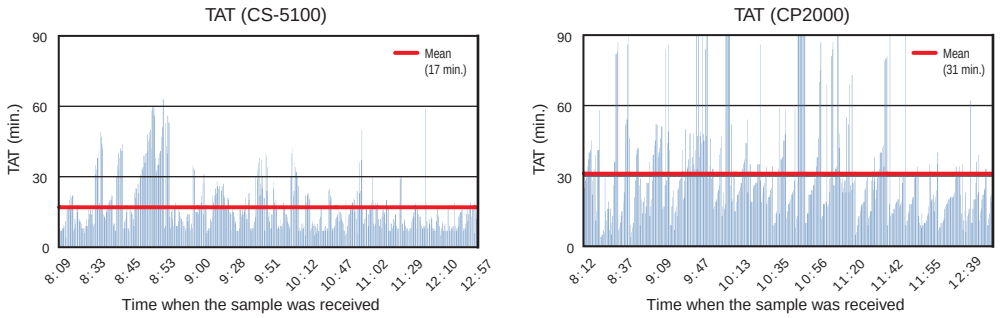

Fig. 3 *Comparison of TAT of CS-5100 and CP2000*

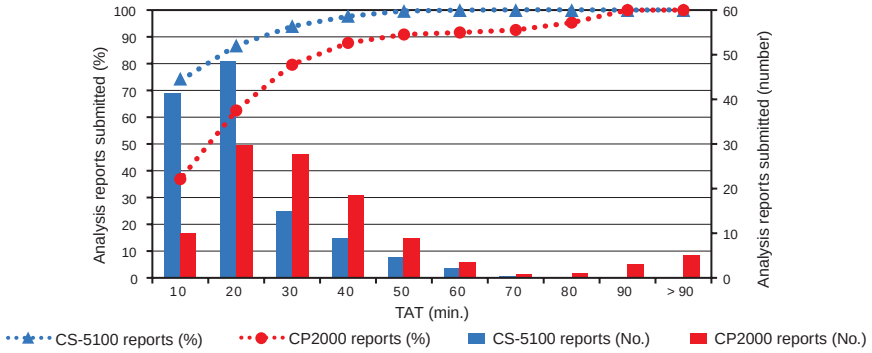

Fig. 4 *Comparison of the percentage and number of analysis reports stratified according to TAT (mean per day)*

thromboplastin, and Dade® Innovin® which contains recombinant tissue factor. In the analysis of PT (%), Thromborel® S tended to give lower values compared to the previously used Thrombocheck PT Plus (y=0.77x+3.35). However, this difference became less when the PT INR values were compared (y=0.90x+0.26). The difference is believed to have been caused by a difference in reactivity, as Thrombocheck PT Plus contains rabbit brain-derived thromboplastin [4]. The analyzed D-dimer value tended to be higher with LIAS AUTO D-Dimer NEO than with previously used Nanopia® D-dimer (y=1.46x-0.18). A difference in the antigen epitope recognized by the two reagents is believed to be responsible for this difference [5,6].

Our laboratory conducts coagulation tests on an average of about 280 samples per day. About half of these samples are from outpatients. Shortening of TAT is important in diagnostic testing and reduced TAT was a major decisive factor in the recent induction of the CS-5100 in our laboratory.

With the CS-5100 the mean TAT was able to be reduced to 17 minutes from the earlier 31 minutes. Moreover, the analysis results of 74% of the samples were reported within 10 minutes. In fact, during the 6 months before induction of the CS-5100 there were 58 telephone inquiries about the results of coagulation tests, but this number came down to 20 in the 6 months after the induction. We believe that this is due to the shorter waiting time on the CS-5100 than the CP2000. All the detectors of the CS-5100 can analyze by the clotting, chromogenic and immunoturbidimetric assays, and allow high throughput analysis of multiple parameters of multiple samples [2,3].

CONCLUSION

We obtained good results in our study of the basic performance of the CS-5100. TAT was significantly reduced. We therefore believe that the CS-5100 is a highly useful, fully automated, coagulation analyzer for accurate analysis and timely reporting of day-to-day hemostasis testing.

References

1) *Yasumuro Y. Automated measurements of thrombosis and hemostasis. Modern Medical Laboratory. 2005; 33(1): 33-39. (Japanese).*
2) *Lawrie AS et al. Evaluation of high throughput multi-wavelength blood coagulation analyzer - Sysmex CS-5100. Sysmex J. 2012; 35 suppl. 1:35-44. (Japanese).*
3) *Mukaide K. An overview of the fully automated blood coagulation analyzer CS-5100. Sysmex J. 2012; 35 suppl. 1: 67-76. (Japanese).*
4) *Yumura S. Performance evaluation of Dade® Innovin® PT reagent. Japanese Journal of Medical Technology. 2008; 57(12): 1377-1386. (Japanese).*
5) *Amemiya N. D-dimer/FDP. Journal of the Japanese Society for Laboratory Hematology. 2006; 7(3): 460-469. (Japanese).*
6) *Ohira C et al. Basic performance evaluation of Nanopia® D-dimer, a D-dimer assay reagent. Japanese Journal of Medicine and Pharmaceutical Science. 2006; 56(1): 95-101. (Japanese).*