A Transport System for Blood Samples, Tempus 600, Stability of Samples and Reduction of Turn-Around-Time

C.L. Brasen[1], J. Hastrup[1], H. Christensen[1], J.S Madsen[1], C.B. Mogensen[2], I. Brandslund[1, 3],
[1] Department of Clinical Immunology and Biochemistry, Hospital of Lillebaelt, Denmark
[2] Emergency Department, Kolding Hospital, Denmark
[3] Institute of Regional Health Research, University of Southern Denmark, Odense, Denmark

Introduction

In Denmark, the hospital sector is being reorganised into more specialized trauma units. Patients treatment is being optimized which includes the need for faster results from blood samples. This could in some way to accomplised using point-of-care test instruments in emergency rooms but the repertoire and quality of the analyses in POCT-instruments are still somewhat reduced compared to regular lab instruments. We therefore developed, in collaboration with TIMEDICO A/S, the transport system TEMPUS600 for blood samples using pressurized tubes. Using this system, samples can be transported to the laboratory in 30-40 seconds. During this procedure, the samples and sample tubes are subjected to acceleration and deceleration which might have an impact on the stability of cellular components leading to hemolysis leading to increased concentration of certain compunds such as potassium and lactate dehydrogenase. It is also of interest if this rapid transportation actually reduces the time from the time of blood sampling to the time when the clinician has the result.

Methods

In order to analyze the impact of the TEMPUS600 transportation system on blood analytes, we included 100 patients consecutively admitted to the Emergency Department in Kolding Hospital. All patients were sampled for three sets of blood tubes. In a random order each set was submitted to one of three ways of handling:

1) Centrifugation immediately after sampling and rushed to the lab. This constitutes the reference value.
2) Transported to the lab using teh TEMPUS600 system.
3) Manually transported to the lab.

The analytes tested is shown in table 2.

We also analyzed the effect of the TEMPUS600 system on the time from sampling to result. The same month of 2013 and 2014 was anayzed in the Emergency Department of Vejle Hospital as shown in fig 2.

Table 2: Routine relative to Tempus transport

	Routine		Tempus					
Name	mean	sd	mean	sd	bias	p-value	n	CV%
Activated Partial Thromboplastin Time	39.66	11.66	39.72	11.54	-0.0607	0.828	61	7
Alanine aminotransferase	34.02	33.28	34.38	33.47	-0.3523	0.027	88	5
Albumin	40.66	4.90	40.63	4.92	0.0360	0.549	89	4
Alkaline phosphate	99.98	158.38	96.92	139.88	30.568	0.013	88	3
Amylase, pancreastype	30.24	19.53	30.22	19.70	0.0112	0.913	89	3
Bilirubin	13.93	34.06	13.62	33.18	0.3136	0.00010	88	8
Calcium	2.28	0.19	2.29	0.19	-0.0049	0.011	89	3
Carbamid	8.22	6.61	8.14	6.55	0.0843	0.082	89	4
Cholesterol	4.26	1.23	4.30	1.23	-0.0399	0.024	90	2
Cobalamin	395.84	273.43	392.00	277.50	38.386	0.00048	88	3
C-reactive protein	46.66	67.57	46.77	67.27	-0.1068	0.875	88	3
Creatine kinase	101.41	120.10	101.63	119.81	-0.2159	0.434	88	5
Creatinine	106.07	108.81	106.38	107.62	-0.3146	0.291	89	4
Fibrin D-Dimer	1.85	2.76	1.85	2.81	0.0026	0.608	54	7
Gamma-Glutamyltransferase	99.80	247.72	99.05	242.60	0.7517	0.938	89	4
Lactate dehydrogenase	208.06	215.09	207.64	211.77	0.4235	0.754	85	3
Leucocyte	9.88	4.14	9.93	4.31	-0.0451	0.787	65	3
Partial Thromboplastin Time	0.84	0.25	0.85	0.26	-0.0117	0.00014	60	9
Potassium	4.13	0.66	4.13	0.68	-0.0035	0.555	88	1
Sodium	140.17	4.84	140.41	4.67	-0.2438	0.109	89	1
Thrombocyte	293.20	103.38	290.05	101.96	31.563	0.190	64	4
Thyroxine	16.60	3.45	16.30	3.46	0.2966	0.0028	89	10
Uric Acid	0.34	0.16	0.34	0.16	0.0003	0.563	89	3

Results

As shown in table 1, when the two transport methods are weighed against each other, the transport method institutes no clinical important changes in concentration of two very telling analytes for hemolysis potassium and lactate dehydronase.

As shown in table 2, a few analytes show significant differences between the transport methods but none are of clinical importance. Difference plots for a number of analytes are shown in fig 1 showing acceptable correlation across the different concentrations.

The time from sampling to ready result in may 2013 versus may 2014 is shown in fig 2 showing a clear reduction in spent time. This change is most evident in the beginning of the sampling round where the clinicians have prioritized a few patients for rapid sampling therefore maximizing the effect of a fast transportation system. The average difference in time was reduced from 85 minutes to 48 minutes.

Table 1: Routine and Tempus relative to a reference value, for Potassium(K), Lactate dehydrogenase(LD) and Haemolytic Index(HI)

			Reference					
	mean	sd	mean	sd	bias	p-value	n	CV%
K Routine	4.11	0.59	4.14	0.59	-0.035	0.016	71	1
K Tempus	4.10	0.60	4.14	0.59	-0.040	0.0005	71	1
LD Routine	172.30	53.41	161.78	54.63	10.522	$9\ 10^{-9}$	67	3
LD Tempus	171.80	54.77	160.74	53.75	11.0571	$8\ 10^{-11}$	70	3
HI Routine	4.21	11.08	1.69	1.80	2.5161	0.010	62	-
HI Tempus	2.93	3.97	1.62	1.80	1.3167	0.0026	60	-

Fig 2: Turn-around-time for samples on the morning round at the Emergency Department in Vejle Hospital. Included are cellular, coagulation and biochemical analytes.

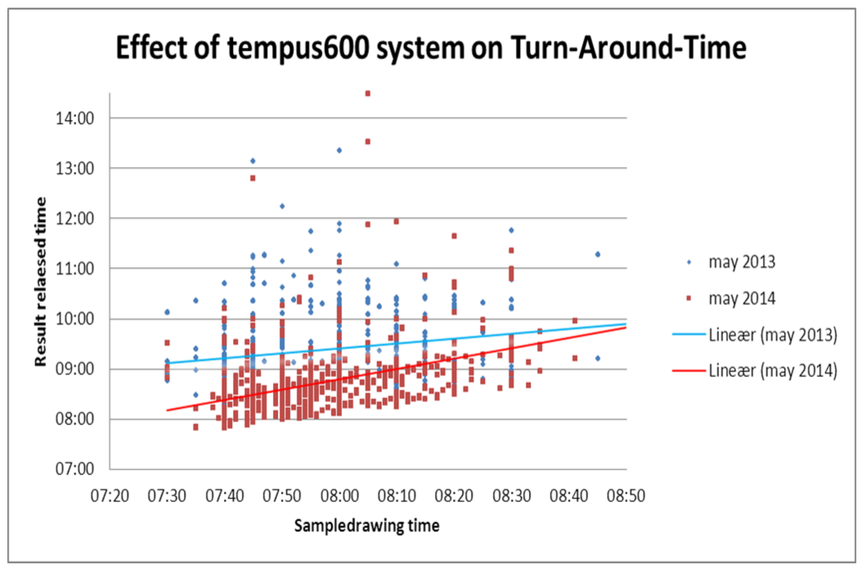
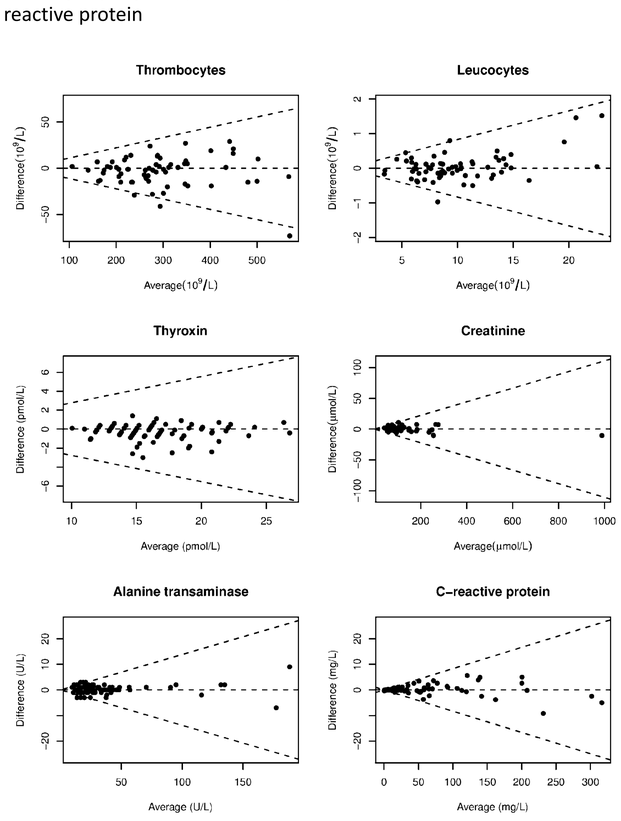


Fig 1: Difference plots for Tempus relative to Routine of Thrombocytes, Leucocytes, Thyroxin, Creatinine, Alanine aminotransferase and C-reactive protein



Conclusion

Together with TIMEDICO A/S we have developed a blood sample air-transport system, which makes it possible to send samples to the hospital laboratory in 30-40 seconds across distances of up to 600 meters.

We have found no clinically important changes induced to any of the tested analytes during an intensive analysis.

Analysing the time from blood sampling to finished result in an Emergency Department in daily usage we found a reduction in time from an average of 85 to 48 minutes but most pronouced for samples which require quick results.

We believe that the TEMPUS600 transport system reduces turn-around-time without instigating any errors in the analytes levels compared to the rutine manual transportation.

A total of more than 60 installations of TEMPUS600 has been setup in 29 hospitals in northern Europe and Southeast Asia.