A Novel Way to Measure Blood Electrolytes and Metabolites

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INTRODUCTION

- Core laboratory chemistry analyzers have long been used to conduct electrolyte (sodium, potassium, and chloride) and metabolite (glucose and lactate) testing for clinical decision-making.
- However, this chemistry analyzer is expensive so that many community hospitals can't afford to have a back up and must send samples to regional centers when analyzer is down or during maintenance. This is a process with big turnaround times and with patient safety risk.
- As blood gas (BG) analyzers are common in laboratories, we sought to investigate the possibility to use BG analyzers as a chemistry analyzer backup for core lab analyzers for critical tests such as electrolytes and metabolites.
- Core lab chemistry analyzers typically use plasma and serum samples while BG analyzers use whole blood as the default sample type.
- In this study, we tested plasma and serum on a BG analyzer and compared results with those were generated by a chemistry analyzer to determine whether these analyzers are interchangeable and whether the differences are of clinical significance.

METHODS AND MATERIALS

- Blood samples (in plasma separator tubes – PST, and/or serum separator tubes - SST) were collected from 53 healthy individuals at the Upper River Valley Hospital, Horizon Health Network (Waterville, New Brunswick, Canada).
- PST/SST samples were run on the Roche Cobas c501 chemistry analyzer then were run on the Radiometer ABL90 blood gas analyzer for sodium (Na^+), potassium (K^+), chloride (Cl^-), glucose (Glu), lactate, and total carbon dioxide (tCO_2) parameters.
- Excel 2016 and IBM SPSS was used for statistics analysis. Because of non-gaussian distribution, data was expressed as medians with interquartile ranges (IQR) and was analyzed with the Wilcoxon signed-pair matched-rank test with p-value < 0.05 as statistically significant.
- Pearson's correlation was used to evaluate relationships of blood results by the c501 with those by ABL90. Bias plots were also made to determine whether the data values from the analyzers were interchangeable with clinical acceptance limits of 4 mmol/L for Na^+, 0.5 mmol/L for K^+, 4 mmol/L for Cl^-, 6 mmol/L for tCO_2, 0.5 mmol/L for Glu, and 0.5 mmol/L for lactate respectively.

RESULTS

Table 1 Correlation and parameter difference statistics between ABL90 and c501 for plasma and serum samples.

Analytes	n	Slope	Intercept	Correlation Coefficient	ABL90 Median (IQR)	ABL90 Range	c501 Median (IQR)	c501 Range	Median Difference (95% CI)	P Value
Na^+ (PST)	53	0.5356	68.548	0.750	144 (4.0)	139-147	141 (2.5)	135-145	3.2 (2.7-3.8)	< 0.05
K^+ (PST)	53	0.9699	0.0335	0.989	4.2 (0.4)	2.8-4.9	4.19 (0.43)	2.92-5.11	-0.09 (-0.1-(-0.08))	< 0.05
Cl^- (PST)	53	0.8386	18.866	0.803	104 (3.0)	100-109	101.3 (3)	96.6-105.7	2.45 (2.1-2.8)	< 0.05
Glu (PST)	53	0.9917	0.1014	0.996	5.4 (1.55)	3.6-14.8	5.35 (1.4)	3.56-14.32	0.05 (0.01-0.10)	< 0.05
Lactate (PST)	53	1.0056	-0.1344	0.998	1.1 (1.1)	0.3-4.8	1.3 (0.9)	0.4-4.9	-0.12 (-0.14-(-0.10)	< 0.05
tCO_2 (PST)	20	1.1652	-1.6516	0.949	28.45 (2.325)	24.3-30.9	25.9 (1.8)	22.1-27.6	2.58 (2.30-2.85)	< 0.05

Analytes	n	Slope	Intercept	Correlation Coefficient	ABL90 Median (IQR)	ABL90 Range	c501 Median (IQR)	c501 Range	Median Difference (95% CI)	P Value
Na^+ (SST)	33	0.5003	73.301	0.709	144 (3.5)	140-147	141 (4)	136-147	2.9 (2.2-3.7)	< 0.05
K^+ (SST)	33	1.0172	-0.1317	0.989	4.2 (0.4)	2.8-4.6	4.28 (0.35)	2.88-4.65	-0.09 (-0.01-(-0.001)	< 0.05
Cl^- (SST)	33	0.9871	3.3034	0.759	103 (3)	101-108	101.5 (2.6)	99.7-104.3	2.0 (1.55-2.43)	< 0.05
Glu (SST)	33	0.9764	0.1196	0.999	5 (2.05)	3.5-10.2	5.07 (2.08)	3.47-10.28	-0.02 (-0.04-(-0.01)	0.387
Lactate (SST)	33	0.9800	-0.1083	0.999	1.3 (0.55)	0.5-5.1	1.4 (0.5)	0.6-5.3	-0.14 (-0.16-(-0.12)	< 0.05

Figure 1

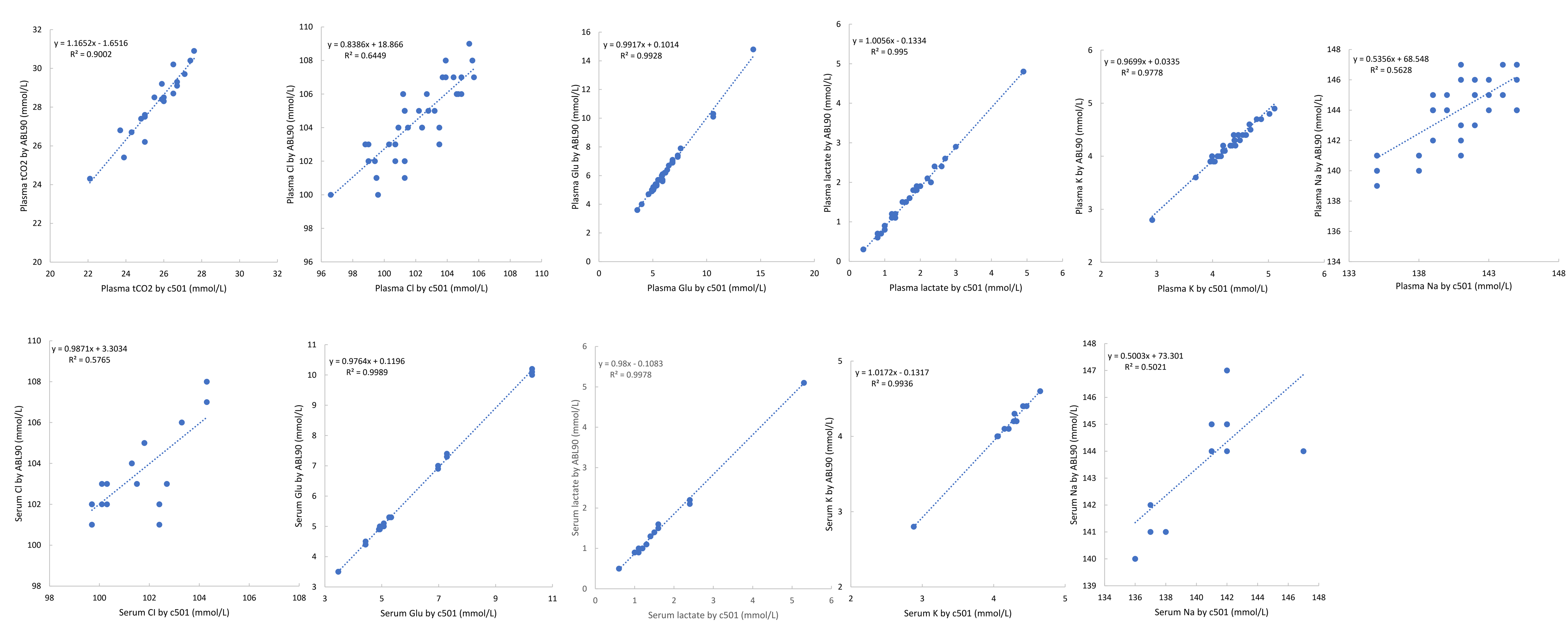
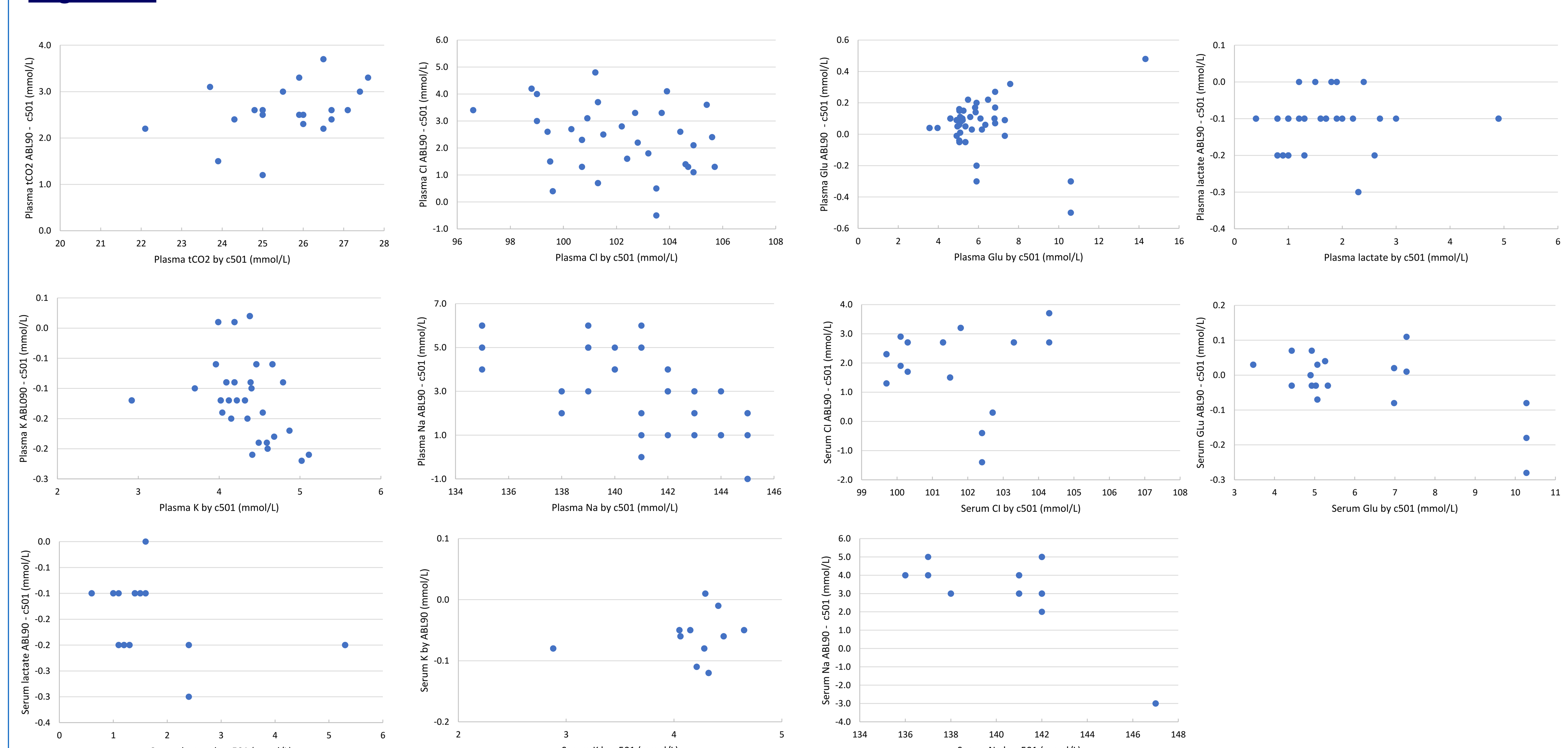


Figure 2



DISCUSSION

- BG analyzers have a lot of potential to be used as backups for core lab chemistry analyzers for the testing of electrolyte and metabolite testing. It can provide a lot of efficient and fast results and it is also cost efficient, especially for rural or small community hospitals.
- Displayed on the graphs, there is especially good correlation in glucose, lactate, and potassium values.
- The only concern is with sodium as there were weaker correlations in these comparisons (0.750 plasma and 0.709 serum). There were also some individual values with bias > 4 mmol/L, however, the median and most values were with bias within 4 mmol/L. Therefore it is still considered within the clinical acceptance limit for sodium.
- There were no clinically significant differences between the two analyzers. The biased values for some variables were not significant enough to reject the BG analyzer as backup for core lab analyzer. Still, regarding sodium plasma and serum values, the results did differ a bit by clinically insignificant values.
- The data proves that ABL90 can be used as a backup for c501 in measuring plasma and serum electrolyte and metabolite concentrations.
- If I were to continue this project, I would compare three groups – serum, plasma, and whole blood from BG analyzers and chemistry analyzers to further research the interchangeability between different sample types and measurement methods of these three groups. Whole blood is different from serum and plasma as it's blood that is not clotted or collected in a tube with anticoagulant - heparin.

CONCLUSION

- In conclusion, the ABL90 blood gas analyzers and c501 chemistry analyzer are interchangeable when comparing metabolite and electrolyte values with plasma and serum sample types. Although further research is needed, there is great potential in the blood gas analyzer as a backup for chemistry analyzer, particularly for small community hospitals.