The accuracy of blood gas analyser results compared with central laboratory testing

Tasmanian Government | Department of Health

Work done at Launceston General Hospital, Launceston, Tasmania, Australia

Bobby V. Li - Canterbury Health Laboratories, Christchurch Hospital, Christchurch, New Zealand; Department of Medicine, Launceston General Hospital, Launceston, Tasmania, Australia;
Lucy J. Reed - Department of Emergency Medicine, Launceston General Hospital, Launceston, Tasmania, Australia

BACKGROUND

Electrolyte and haemoglobin results from blood gas analysers are often used clinically before results from central laboratory testing are available. However, the accuracy of blood gas analyser results is uncertain.

METHODS

Patients who presented to the emergency department from 1 January 2018 to 7 January 2018 and with blood gas analyses (Werfen Gem 3000 blood gas analyser) and central laboratory (Roche cobas 6000 c501 and Sysmex XE5000) samples timestamped ≤20 minutes apart were included in the study. Mean differences in sodium, potassium, bicarbonate, haemoglobin and haematocrit between central laboratory results and blood gas results were calculated. Samples with haemolysed or clotted comment were excluded. Differences were tested using t-tests, compared with RCPA analytical performance specifications, and plotted on Bland Altman Plots. Passing Bablok Regression was performed between concentrations reported on blood gas with those reported from the central laboratory.

RESULTS

55 sets of corresponding samples were analysed.

All blood gas samples during the study period were venous samples.

Compared with venous blood gas results, mean central laboratory results were higher for sodium (5.0 mmol/L, 95% CI (4.4, 5.5), p<0.001) with 47/55 observations outside RCPA analytical performance specifications, and potassium (0.31 mmol/L, 95% CI (0.27, 0.35), p<0.001), with 35/55 observations outside RCPA analytical performance specifications.

Mean central laboratory concentrations were lower for bicarbonate (-4.4 mmol/L, 95% CI (-4.9, -3.9), p<0.001), with 48/55 observations outside RCPA analytical performance specifications, and haematocrit (-2.3%, 95% CI (-3.4, -1.2), p<0.001), with 2/52 observations outside RCPA analytical performance specifications.

Mean concentration did not systematically differ for haemoglobin but had lower correlation (3.6 g/L, 95% CI (-0.4, 7.6), p=0.074), with 26/49 observations outside RCPA analytical performance specifications.

BASELINE STATISTICS FOR RESEARCH	
Variable	**Median (IQR) or proportion (%)**
Male	31/55 (56%)
Age (years)	63 [37-76]
pH VBG	7.40 [7.375-7.445]
pCO_2 VBG (mmHg)	37 [28-48.5]
HCO_3^- VBG (mmol/L)	27 [25-30]
Na^+ VBG (mmol/L)	135 [131-137]
K^+ VBG (mmol/L)	3.8 [3.65-4.05]
Glucose VBG (mmol/L)	6.2 [5.55-7.55]
Lactate VBG (mmol/L)	1.4 [1.0-2.1]
Na^+ UEC (mmol/L)	140 [136-141.5]
K^+ UEC (mmol/L)	4.1 [3.9-4.4]
Cl^- UEC (mmol/L)	99 [96-101.5]
HCO_3^- UEC (mmol/L)	23 [22-25]
Creatinine UEC (µmol/L)	77 [61-104]

Table 1: *Baseline statistics. VBG: venous blood gas. UEC: urea, electrolytes and creatinine panel*

Passing Bablok regression central lab vs VBG Na+

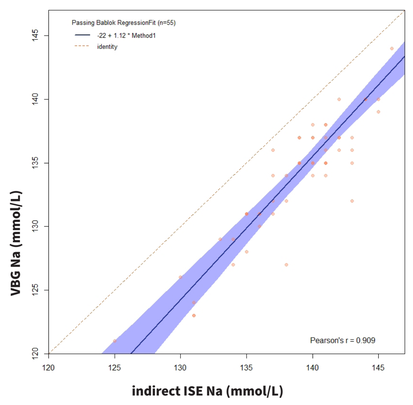

Figure 1: *Passing Bablok regression for central laboratory sodium vs blood gas sodium concentration. ISE: ion selective electrode. VBG: venous blood gas.*

Bland Altman plot VBG vs indirect ISE Na

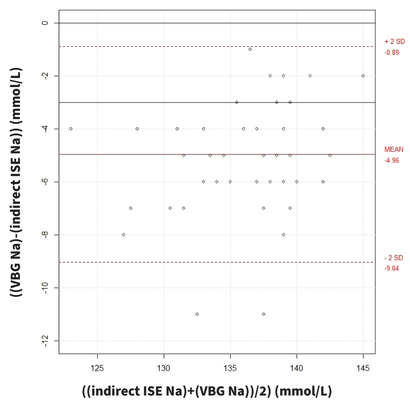

Figure 2: *Bland Altman plot for central laboratory sodium vs blood gas sodium concentration. 47/55 observations outside RCPA analytical performance specifications (±3 up to 150; ±2% >150 mmol/L). ISE: ion selective electrode. VBG: venous blood gas.*

Passing Bablok regression central lab vs VBG K+

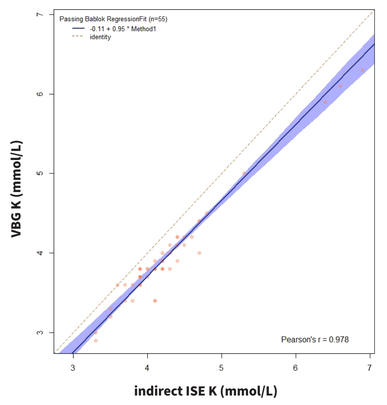

Figure 3: *Passing Bablok regression for central laboratory potassium vs blood gas potassium concentration. ISE: ion selective electrode. VBG: venous blood gas.*

Bland Altman plot VBG vs indirect ISE K

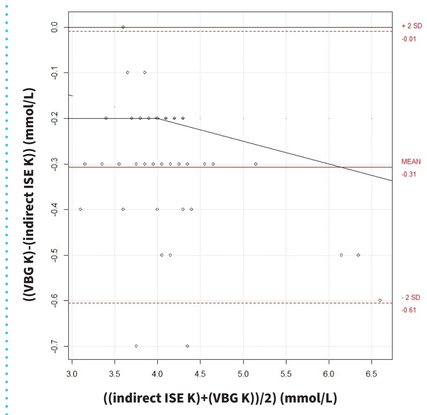

Figure 4: *Bland Altman plot for central laboratory potassium vs blood gas potassium concentration. 35/55 observations outside RCPA analytical performance specifications (±0.2 up to 4.0; ±5% >4.0 mmol/L). ISE: ion selective electrode. VBG: venous blood gas.*

Passing Bablok regression central lab vs VBG HCO3-

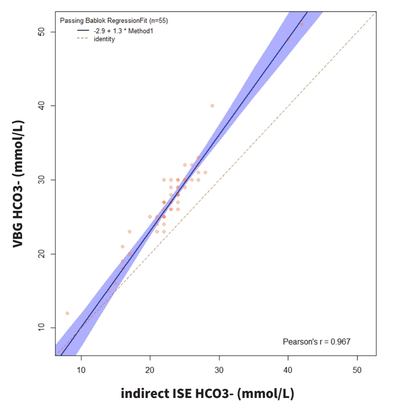

Figure 5: *Passing Bablok regression for central laboratory bicarbonate vs blood gas bicarbonate concentration. ISE: ion selective electrode. VBG: venous blood gas.*

Bland Altman plot VBG vs indirect ISE HCO3-

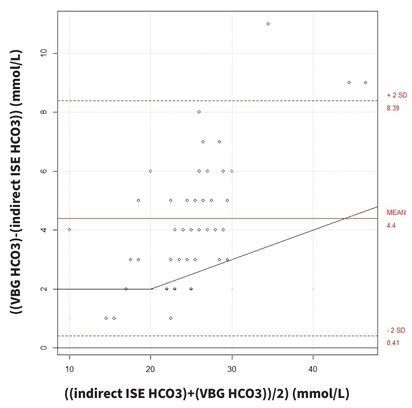

Figure 6: *Bland Altman plot for central laboratory bicarbonate vs blood gas bicarbonate concentration. 48/55 observations outside RCPA analytical performance specifications (±2.0 up to 20.0; ±10% >20.0 mmol/L). ISE: ion selective electrode. VBG: venous blood gas.*

Passing Bablok regression central lab vs VBG Hb

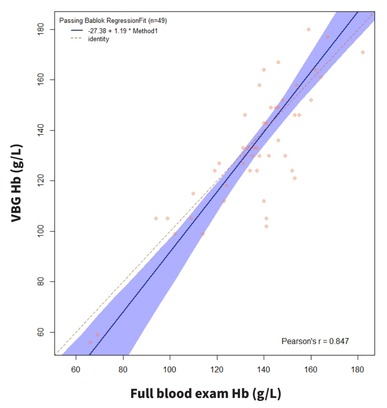

Figure 7: *Passing Bablok regression for central laboratory haemoglobin vs blood gas haemoglobin concentration. VBG: venous blood gas.*

Bland Altman plot VBG vs Full blood exam Hb

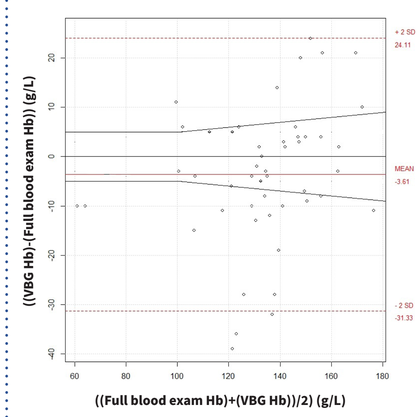

Figure 8: *Bland Altman plot for central laboratory haemoglobin vs blood gas haemoglobin concentration. 26/49 observations outside RCPA analytical performance specifications (±5 up to 100; ±5% >100 g/L). VBG: venous blood gas.*

Passing Bablok regression central lab vs VBG Haematocrit

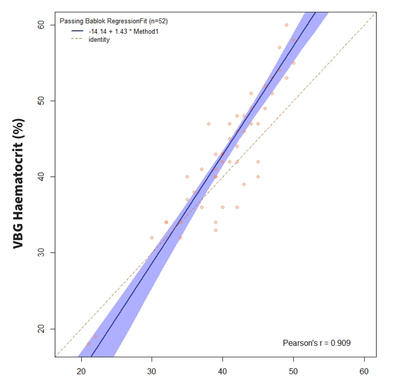

Figure 9: *Passing Bablok regression for central laboratory haematocrit vs blood gas haemoglobin. VBG: venous blood gas.*

Bland Altman plot VBG vs Full blood exam Haematocrit

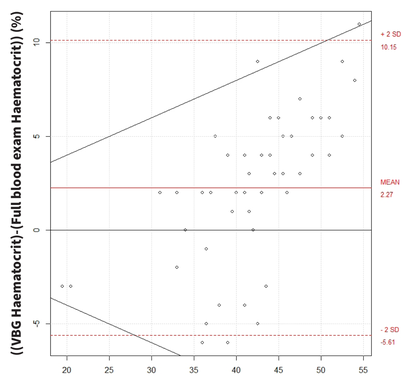

Figure 10: *Bland Altman plot for central laboratory haematocrit vs blood gas haematocrit. 2/52 observations outside RCPA analytical performance specifications (±0.04 up to 0.20; ±20% > 0.20). VBG: venous blood gas.*

CONCLUSION

During the study period sodium and potassium concentrations were significantly higher as measured in central lab bloods than in the emergency department blood gas machine. Although the difference in potassium concentration was possibly attributable to the use of serum samples in the lab and not clinically significant, the difference in reported sodium concentrations was quite large. On the other hand, HCO_3^- concentration reported was significantly lower in central laboratory bloods.

Blood gas results may differ systemically and have moderate to excellent correlation with central laboratory testing.

Analysers should be calibrated to minimize systematic errors and clinicians should be aware of differences to facilitate appropriate clinical decision making.

The blood gas analyser involved has since been replaced.

Work done at Launceston General Hospital, Launceston, Tasmania, Australia

Tasmanian Government | Department of Health