

A Comparative Study of Arterial Blood Gas (ABG) Values in Relation with Time and Temperature

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Abstract

We conducted a comparative study, and compared the arterial blood gas values with respect to time 0, 5, 10, 15, 20 mins after sample collection and temperature at 0°C and 22°C degree arterial blood gas sample was collected from dorsalis pedis artery before induction of general anesthesia in 100 patients of ASA Grade I and II posted for all type of elective surgeries. The samples were randomly allocated into two groups. In Group A at 0 degree Celsius, and in Group B, 22 degree Celsius. parameters noted pH, pCO₂, pO₂, standard bicarbonate, base excess, O₂ and CO₂ at 0, 5, 10, 15 and 20 minutes. Statistical analysis was done with *t*-test.

Keywords: pH - Hydrogen ion concentration; pCO₂ - Partial pressure of CO₂; pO₂ - Partial pressure of O₂; O₂ - Oxygen content; CO₂ - CO₂ content; BE - Base excess.

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Introduction

- ABG analysis plays an important part in management of patients in OTs/ ICUs
- Delayed analysis, storage fallacies may cause altered results, influencing patient management

Materials and Methods

We conducted the study in Basaveswara Medical College and Hospital and Research Centre, Chitradurga.

Patients

- 100 ASA I/II patients of either sex (18–55 yr) posted for Elective major surgeries;
- Between Sep. 2017 and Aug. 2018

The Machine

Ciba Corning 248 ABG Analyzer ;
Cold Storage/Ice pack;
Lab thermometer (0°C–50°C).

Exclusion Criteria

- Patient Refusal;
- Sepsis and fever;
- Significant coagulation defects;
- In-sufficient collaterals in 'sampling' limb;
- Suspicion of incorrect storage (air/temp).
- Routine PAE;
- Investigations incl. Hb%;
- Patient Explanation and Consent;
- Midazolam @ 0.02 mg/Kg I.V.
- Basal Monitors connected.

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Methods

- Samples collected anaerobically in 2 ml heparinised syringes from Dorsalis pedis Artery:
before induction of GA (FiO₂ = 0.21) under LA (22 # 'Venflon');
- Allotted randomly to 2 Groups of 50 each and samples analyzed:
Group A: Stored/transported at 0°C;
Group B: Stored at 22°C (Lab temp).

Parameters noted

- pH, P_cO₂, PO₂ and
- Standard Bicarbonate., BE, O₂ & CO₂ Content at 0, 5, 10, 15 and 30 minutes.

Compared within each Group and statistically analyzed with paired *t*-test (SPSS for Windows version 16).

Machine Factors and Error

pH: 6.5–8.00 pCO₂: 5–250 .0 mm Hg
 pO₂: 0.0–749.0 P_{atm}: 400–825 mm Hg
 Temp: 15°C–32°C HCO₃ (act or std): 0.0–60.0 mmol/l
 BE (ecf or B) : ±29.9 mmol/l
 CTCO₂ : 0.0–60.0 mmol/l
 O₂SAT : 0.0–100% O₂CT : 0.0–40.0 ml/dl
 PO₂ (A-a) : 0.0–749.0 mm Hg (0.0–99.86 kpa)
 PO₂ (a/A) : 0.0–1.00

Results

Group A (0°C):

1. pH remained extremely stable in > 80% of patients and varied minimally in the rest: from - 0.21 to + 0.40% (0.015 unit fall);
2. pCO₂ Very minimal changes. (-0.4 to + 0.2%) Not Significant ... (0.08 mm Hg average ↑);
3. pO₂ Remained stable with small falls but statistically in-significant relative increases at 30 min (Fall of 2.03 mm Hg at 30 min);
4. Bicarbonate Minimal changes at 5 min to no changes later : - 3.43 to + 7.93;
5. BE not much significant change
6. O₂ content No significant change;
7. CO₂ content Minimal changes throughout.

Group B (22°C):

1. pH- Varied by: - 0.37% to + 0.40% over 30 min period Overall, very stable 14 pts and slightly fell in rest (36) there was relative falling trend from 15 Min onwards (Mean 0.317% or 0.024 Units)
2. pCO₂- Varied by: -9.19% to + 8.76%, majority having a rise throughout but a relative fall at 15 min. (Av. rise of 2.1 mm Hg at 30 Min)
3. pO₂- Varied by: - 8.97 to + 12.4% but overall there was a fall of with relative increases seen after 15 min. Av fall at 30 min: 2.83 mm Hg.
4. Bicarbonate- Varied by: - 6.51 to + 13.66% (↑ 0.45–0.71 mmol/l)- highest changes were seen bet. 15 Min and 30 min. Statistically not significant.
5. BE Statistically not significant at all times (± 0.028 mmol/l)
6. O₂ content No change up to 15 min., then

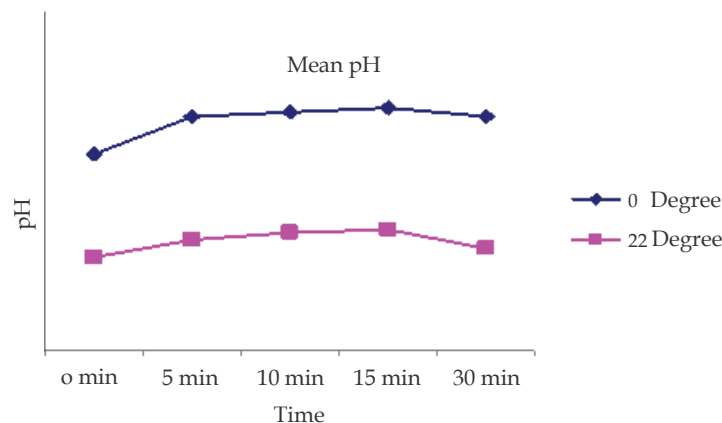


Fig. 1: pH Changes over time at 0°C & 22°C

changed marginally (-2.54 to + 1.5%) ($\downarrow 0.136 \text{ ml\%}$)

Discussion

7. CO_2 content Trend of fall seen after 15 Min, persisting till 30 min (-7.8 to + 13.6%)

ABG analysis is useful in critically ill patients:

- Standard ABG analyzers are costly to buy

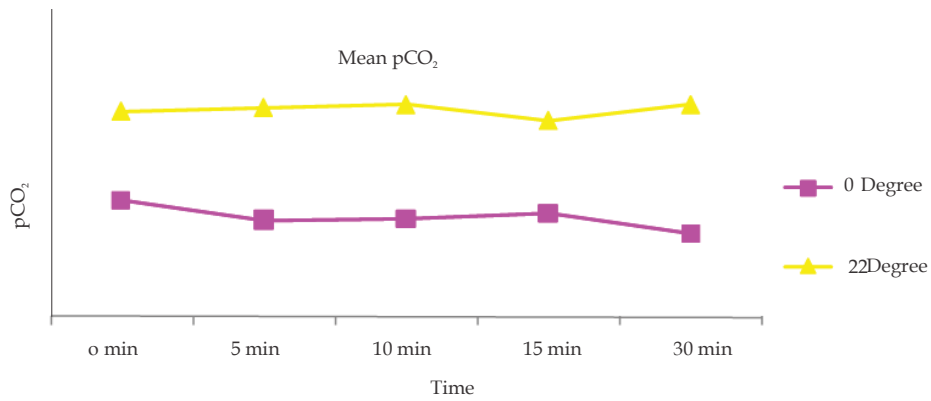


Fig. 2: pCO₂ Changes over time at 0°C & 22°C

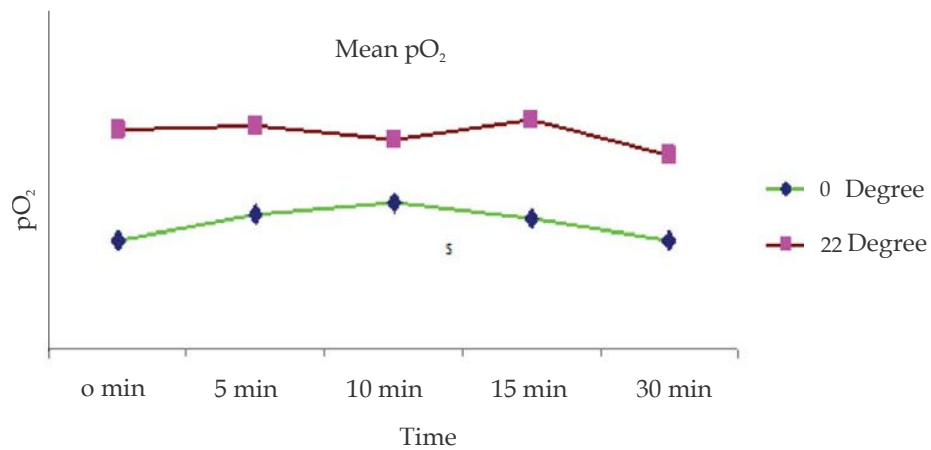


Fig. 3: pO₂ Changes over time at 0°C & 22°C

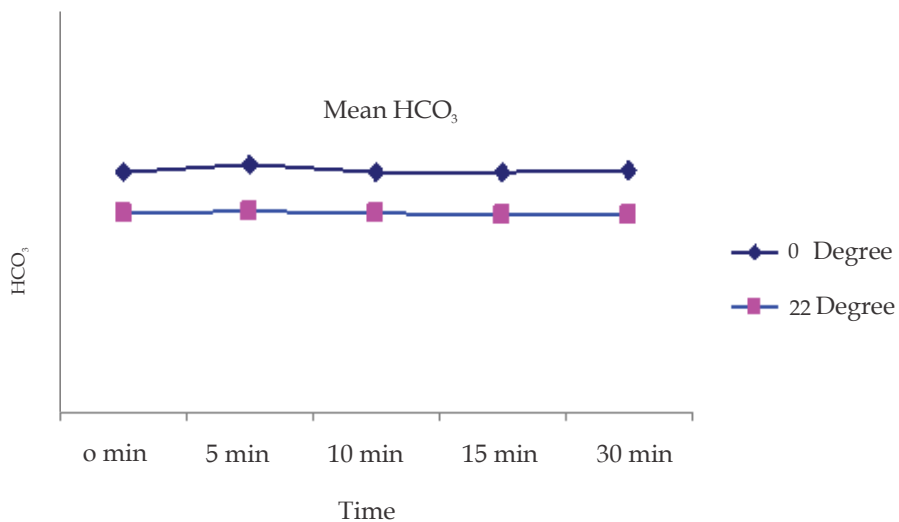


Fig. 4: Bicarbonate Changes over time at 0°C & 22°C

Table 1: Average results of all parameters at 0^o and 22^oC with respect to Time

Parameter	Av. Changes 0 to 30 min			
	0 ^o C	Remarks	22 ^o C	Remarks
pH	↓0.015	Stable	↓0.024	↓15 th Min
pCO ₂ (mm Hg)	↑ 0.08	Stable	↑ 2.1	Small ↓ 15 th Min
pO ₂ (mm Hg)	↓ 2.03	Stable	↓2.83	Small ↑ 15 th Min
HCO ₃ (mmol /lt)	±0.029	Stable	±0.631	Changes highest after 15 th Min
B E (mmol / l)	±0.018	Stable	±0.028	Stable
CtO ₂ (ml%)	↓0.129	Stable	↓0.136	After 15 th Min
CtCO ₂ (ml%)	↓0.421	Stable	↓0.7	After 15 th Min

(> Rs 4 lacs) and costly to maintain (*min.* 15,000 for 45 days for solutions);

- A single machine in a hospital may cater to large number of patients, probably with waiting list and delayed analysis;

Delay in analysis can cause the following changes:

Reduce pH¹: Anaerobic glycolysis by RBCs, WBCs, Reticulocytes leads to production of organic acids. Fall in pO₂² with corresponding smaller changes in plasma Bicarbonate and pCO₂: because of continued blood buffering.

These changes with time can be minimized by:

- (a) Can be minimized by reducing the temperature of blood;
- (b) Cooling reduces rate of metabolism of cells^{1,2};
- (c) Immersing in ice (0^oC) will preserve the cells better than storage at any other temperature⁵⁻⁷;

There is a 'tendency to hurry through' the various steps in ABG analysis, Hence, we studied changes in the ABG values at different intervals after withdrawal, at 0^oC and 22^oC and found that results shows in **Table 1**.

Conclusion

It is best to analyze the sample anaerobically immediately or within 15 *min*, at both 0^oC and 22^oC. If there is possibility of delay up to 30 *min*, the sample may be stored ideally at 0^oC, as storage at 22^oC is associated with changes (albeit in-significant statistically) after 15 *min*.

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