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Original Article
ABG: Gold Standard in Emergency Department –A Randomized Trial

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Abstract
Background: *Analyzed report of Arterial Blood Gas is indicated in almost all patients admitted through emergency department (ED). ABG measurements are widely used in hospitals now a day. Its use is particularly confined in ICU as monitor due to lack of test of accuracy and availability of simple method of analysis, Management if started after correlating the clinical diagnosis with that of ABG diagnosis, mortality is reduced and discharge is improved.*
Method: *Prospective randomized controlled trial had been done over 136 patients of ED. Allocation ratio was 1:1. One group was managed in the background of analyzed ABG measurements and the control group was managed according to the traditional method. The ABG measurements were analyzed according to "rkdas Indian 2017 method of ABG interpretation". The primary and secondary outcomes were assessed statistically. Patients and outcome access were blinded.*
Result: *The percentage of death in the study group is significantly less than the control group (p-value 0.22) with 95% confidence interval (3.08 – 17.52). The percentage of discharge is significantly more in study group than control group (p-value 0.036) with 95% confidence interval (50.25 -73.35).*
Conclusion: *Management in the background of interpreted ABG decreases the mortality and improves the number of discharge.*
Keywords: *ABG (Arterial Blood Gas), ED (Emergency Department), HAGMA (High Anion Gap Metabolic Acidosis), NAGMA (Non Anion Gap Metabolic Acidosis), ABG in ICU.*

Introduction

Arterial Blood Gas (ABG) measurements are now widely used in hospitals. Its wide utility is confined to ICU as monitor due to lack of test of accuracy. Accuracy is tested by knowing the difference of measured and derived HCO_3^- which should fall in between ± 2. But no ABG machine measures HCO_3^-. Due to this shortcomings if the clinical diagnosis does not match with ABG findings, doctor level it inaccurate. At the same time, available methods of interpretation are incomplete and difficult to be understandable by general doctors and nurses. Thus its wide use in emergency department (ED) is not as it should be. "rkdas Indian 2017 method of ABG interpretation", evaluates accuracy by different methods and analyses the measurements in different simple steps. It is so simple that analysis can be done even by nursing staff within 05 minutes. With the introduction of this method ABG has become the most accurate test possible without restriction in ED which helps the treating

physicians in diagnosis, understanding prognosis of some seriously ill patients, referral and treatment plan. Its use decreases the mortality, increases the discharge and decreases in-hospital stay of the patients admitted through ED.

Method

This is a parallel trial design. The patients were randomized in two groups by simple random allocation process. There were 17 blocks. Each block randomized 8 patients with first four assigned non intervention and the last four assigned intervention. Allocation ratio was 1:1. Allocation concealment was done by sequentially numbered sealed envelope. Patient and outcome accesses were blinded. Prospective randomized control trial had been started after getting ethical approval from ethics committee of Darbhanga Medical College, Laheriasarai, Bihar, India.

136 patients admitted in emergency department (ED) of Darbhanga medical college and hospital were selected for the study. Their attendants given the signed consent. One ml arterial blood in 2ml heparnized syringe were collected from 68 patients prior to start of therapy and transported to ABG lab according to the protocol. The ABG measurements were done by Cobas b 121 machine. The analysis of measured value was done within 5 minutes. Provisional clinical diagnosis were tried to be correlated with ABG analysis. Their management was started in the background of interpreted value of ABG. The same number of patients was selected for management by traditional method. Outcome was measured as primary and secondary. Primary outcome was measured from mortality and discharge of patients. Secondary outcome was measured from in-hospital stay. Outcome was recorded and assessed statistically in the last. Number of referral and lama (left against medical advice) were pointed out. Trial outcome criteria had not been changed. No one was excluded after randomization. Period of recruitment was between 5.2.2018 to 15.08.2018. No follow up were done. Trial was stopped due to non specific reason.

ABG analysis was done according to the following proforma:-

"rkdas Indian 2017 Method of ABG interpretation"

I.   Accuracy of ABG
1. The difference of measured HCO_3^- and derived HCO_3^-
2. Relation of pH to H^+
3. Hb% measured through CBC and ABG
4. SPO_2 derived by machine and measured by pulse oximeter

II.   Gas Analysis
1. SpO_2
2. PaO_2
3. Relation between PaO_2 & SpO_2
4. PaCo2
5. Type of RF
6. $PAO_2 = 150 - 1.25 \times PaCO_2$
7. $P(A\text{-}a)O_2$
8. Cause of hypoxemia
9. P/F i.e. PaO_2/FiO_2
10. Oxygen content (CaO_2)

$CaO_2 = Hb(gm/L) \times 1.34 \times SPO_2/100 + 0.03 \times PaO_2$.

III.   Electrolyte Analysis
1. Osmolality
$$= 2 \times Na(mEq./L) + \frac{Plasma\ glucose\ (mg/dl)}{18} + \frac{BUN(mg/dl)}{2.8}$$
where $BUN = \frac{Blood\ urea(mg/dl)}{2.14}$
2. Blood volume $= \dfrac{2L}{Hct(\%)}$, when no anemia and polycythaemia
3. Na+ and cause
4. The cause of K^+ derangement is correlated with pH
5. Chloride generally change in parallel with plasma Na^+.
6. Free calcium
7. $AG = (Na^+ + K^+) - (Cl^- + HCO_3^-)mmol/L$
8. $\Delta\ gap$ + Hco3
9. Gap-Gap ratio
10. BE

IV.   Acid-Base Analysis
1. pH & H^+
2. HCO_3^-
3. Direction of movement of H^+ and HCO_3^-

4. In. Respiratory Cause $\frac{\Delta H+}{\Delta CO2}$ value
5. PaCO$_2$
6. Direction of movement of PaCO$_2$ and HCO$_3$
7. Compensatory change
8. In High AG Metabolic acidosis take help of gap/gap
Ratio; $\Delta\ gap$ + Hco3.
9. Diagnosis

V. Complete Diagnosis

For statistical analysis SPSS version 20 software had been used. Categorical variables were expressed as number of patients and percentage of patients and compared across the groups using Pearson's chi square test for independence of attributes/Fisher's exact test as appropriate. Continuous variables were expressed as mean, median and standard deviation and compared across the groups using unpaired test. An alpha level of 5% had been taken, i.e. if any p-value is less than 0.05 it had been considered as significant.

Result

In the study group there were 31 (45.6 %) female and 37(54.4%) male while in the control group there were 36(52.9%) female and 32(47.1%) male. The difference of sex in both the groups were not significant (p-value 0.390). In the case group mean age was 49.34 with SD 17.29 while in control group it was 49.50 and 16.99 respectively. No significant difference (p-value 0.956) (Table-1).

The patients were characterized clinically in different groups (Table-2). Here the difference in number of patients between the groups were not significant except in sepsis and multi organ disease.

From ABG of 68 patients of study group, 12(17.6%) were found inaccurate by BE method. When the relation between pH and H+ of those 12 patients were matched in pH and H+ table, they were matching with each other and thus accurate.

Hypoxemia was found in 33(49.5%) patients and severe hypoxemia was found in 4(5.9%) (Table 3). Type 1 RF was seen in 5(7.35%) and all were of moderate hypoxemia. Type 2 RF was found in 9(13.2%) in which 3(4.4%) were due to hypoventilation only and 4(5.9%) were associated with severe hypoxemia, 1(1.5%) had moderate hypoxemia and 1(1.5%) had mild hypoxemia. Hyponatremia was found in 58(85.3%) patients while Hypernatremia conspicuously absent in the study group. Hypokalemia was found in 32(47.1%) while Hyperkalemia in 13(19%) patients (table 3). Cl$^-$ value was present in 65(95.6%) of ABG. Out of this hypochloremia was present in 42(64.6%) while hyperchloremia in 4(6.2%) patients. Acidemia in 13(19.1%), alkalemia in 32(47.1%), normal pH in 23(33.8%) in which 22(33.4%) were compensated and only 1(1.5%) patient had no acid-base disorder. Primary respiratory cause in 42(61.8%) and primary metabolic cause in 25(30.8%) of patients. Out of 42 patients of primary respiratory cause acute or chronic respiratory alkalosis was present in 21(50%), chronic respiratory alkalosis in 8(19%), acute respiratory alkalosis in 6(14.3%), acute or chronic respiratory acidosis in 3(7.1%), chronic respiratory acidosis in 4(9.5%) and there was 0(0%) case of acute respiratory acidosis. Out of 25 patients of primary metabolic cause HAGMA was present in 3(12%), NAGMA in 2(8%), HAGMA with NAGMA in 8(32%), Metabolic alkalosis in 11(44%) and HAGMA with metabolic alkalosis in 1(4%). In the study, patients of mixed disorder were 51 (75%), simple acid-base disorder in 16(23.5%) and no acid-base disorder in 1(1.5%) patient.

Finally both the study and control group were compared. Death in ABG group was 7(10.3%), 95% confidence interval (3.08 - 17.52), compared to control group 17 (25%), 95% confidence interval (14.71 - 35.29) and p-value 0.022. Discharged patients in study group were 42(61.8%), 95% confidence interval (50.25 - 73.35) while in control group were 30(44.1%), 95% confidence interval (32.3 - 55.9) and p-value 0.036. Difference of LAMA and referral in

between the groups had p-value 0.436 & 0.250 respectively, which was not significant.

The overall in-hospital stay in the case group was 4.38 days with SD 2.79 while in control group it was 4.93 with SD 2.82, more in control group than study group but not significant . The mean difference (effect size) of discharge patient was -0.55, 95% confidence interval of the difference falls between -1.89 to 0.78.

Statistical Table

Table- 1 Statistical demographic

Sex	Case		Control		P-value	Significance
	Frequency	Percent (%)	Frequency	Percent(%)		
Female	31	45.6	36	52.9	0.390	**Not significant**
Male	37	54.4	32	47.1		
Age(yrs)	Mean	SD	Mean	SD	0.956	**Not significance**
	49.34	17.29	49.50	16.99		

Table-2 Clinical characterization

	Case	Control		
	N(%)	N(%)	p Value	Significance
Respiratory	10(14.71)	9(13.24)	0.805	Not Significant
Gastrointestinal	3(4.41)	3(4.41)	1.000	Not Significant
Cardiovascular	6(8.82)	5(7.35)	0.753	Not Significant
Sepsis	1(1.47)	7(10.29)	0.026	Significant
Cerbrovascular Accident	5(7.35)	12(17.65)	0.066	Not Significant
Cardiopulomonary	4(5.88)	6(8.82)	0.510	Not Significant
Multiorgan Disease	9(13.24)	0(0)	0.001	Significant
End Stage Renal Disease	1(1.47)	2(2.94)	0.559	Not Significant
CKD with HF	1(1.47)	1(1.47)	1.000	Not Significant
Hepato Biliary Disease	2(2.94)	3(4.41)	0.648	Not Significant
DM	1(1.47)	1(1.47)	1.000	Not Significant
Diabetic Complication	9(13.24)	4(5.88)	0.142	Not Significant
Others	16(23.53)	15(22.06)	0.838	Not Significant

Table-3 Primary Outcome

	Case			Control			p Value	Significance
	Frequency	Percent	95% Conf Interval	Frequency	Percent	95% Conf. Interval		
Death	7	10.3	3.08 - 17.52	17	25	14.71 - 35.29	0.022	Significant
Discharged	42	61.8	50.25 - 73.35	30	44.1	32.3 - 55.9	0.036	Significant
LAMA	10	14.7	6.28 - 23.12	7	10.3	3.08 - 17.52	0.436	Not Significant
Refer	9	13.2	5.15 - 21.25	14	20.6	10.99 - 30.21	0.25	Not Significant
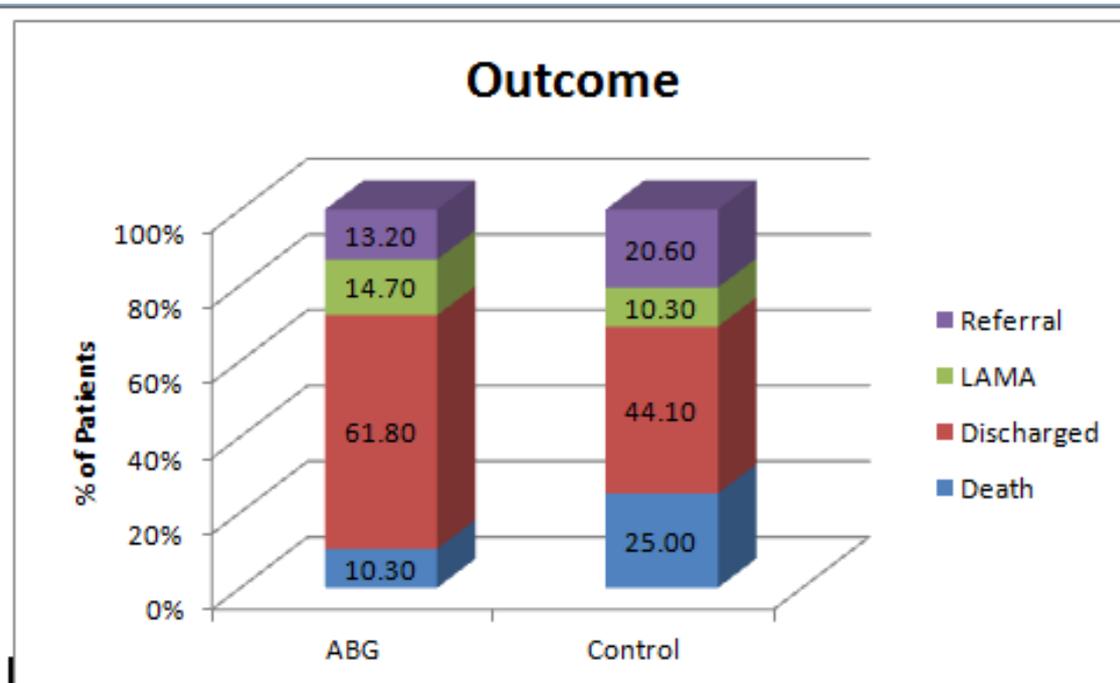
Fig-1, Bar Diagram of Outcome in percentage.

Discussion

In my study 17.6% of ABG were inaccurate when assessed by BE method in emergency patients, while in general patients the difference between measured and derived HCO_3^- ($\pm$ 2) was not found in 4.5% only[6]. ABG of 80.9% of patients matched with provisional and final clinical diagnosis, while there were only 42.6% of patients whose provisional and final clinical diagnoses were the same. ABG in advance predicted the change of provisional diagnosis in 38.3% of patients.

Both the groups characterized clinically have difference in number of patients which is not significant. The only significant number is in sepsis and multi organ disease. Previous work by different authors suggest that outcome in both the group is similar. In hospital mortality is 10 – 29%. [10].

In 5.9% of severe hypoxemia, pulse oxymeter was not useful. Out of 13.2% patients of COPD, acute exacerbation of COPD was provisionally diagnosed in 4.4% patients but only 1.5% had acute or chronic respiratory acidosis (acute exacerbation of COPD), while 8.8% patients were clinically diagnosed as copd/cor - pulmonale in which 3% patients had acute or chronic respiratory acidosis (acute exacerbation of COPD).

Out of 10.3% patients died during therapy, ABG predicted in almost all cases about the seriousness. There were 5.9% patients of acute heart failure in which 2.9% had metabolic acidosis and died, 1.5% had normal pH and 1.5% had alkalosis, they survived [8]. There was 1.5% case of AMI and pH was 7.25. In acute coronary syndrome if pH is < 7.3- mortality is expected to be 100% [7]. 2.9% patients of arrhythmia had acidosis. They succumbed during therapy. Acidosis contributes to the development of arrhythmia and the patient was resistant to therapy. One patient had CVA with altered sensorium and the PaO_2 was 50%. Commonly there is hyperventilation in CVA and PaO_2 should not be low. There was associated aspiration pneumonia. 1.5% patient who died was a case of complex disease with pH 7.50. Mortality was high in complex disease & pH >7.55.

Management of all the patients of the study group was done in the background of analyzed report of ABG and according to the protocol of the disease.

There were 4.4% cases of acute exacerbation of COPD, 1.5% had pH 7.32 and managed with Bi-pap, the 2.9% had pH 7.12 and 7.21, 1.5% was associated with non anion gap metabolic acidosis, thus treated with Bi-pap and improved, while the other needed ventilator but refused and left against medical advice. 20.6% patients were of type I & type II RF. Their cause were decided by algorithm and managed accordingly. ABG acted as monitor in all the 75% mixed disorder, patients.

The outcome of the two groups shows that patients treated in the background of ABG had mortality less by 14.7% than control group, which is significant. At the same time discharge with advice in ABG group is more by 17.7% than control group which is also significant. The overall stay of the discharge patients were less in case group. Although it needs further study.

Conclusion

ABG is essential in emergency department. It is indicated in almost all presenting problems in ED. ABG helps in diagnosis of diseases. It helps to decide acute exacerbation of COPD. In all patients it can decide severity of hypoxemia. It is also indicated in all cardiac emergencies. In majority of seriously ill patients it predicts the prognosis in advance. It is a useful monitor in ventilated patients and patients of multi-organ failure. It helps in deciding early referral of the patients. Diagnosis and management in the background of analyzed value of ABG decrease the mortality in critically ill patients and decreases in-hospital stay of discharge patients.

Sample size was not determined because there are no matches of work. Simple randomization has been done. Allocation concealment was done by sequentially numbered sealed envelope. Random allocation enrollment was done by PG student. I myself assigned participants for intervention. Patients and outcome accesses were blinded.

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