Original Research Article

Severe metabolic acidosis in critically Ill patients and its association with the outcome in North Karnataka

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ABSTRACT

Background: Outcomes of metabolic acidosis remain unsure and needs to be explored deeply. This article presents a rational approach to diagnosis and management of metabolic acidosis. The data focusing specifically on severe metabolic acidosis (pH<7.20) is scanty.
Methods: It was a prospective observational study. A total of 50 consecutive critically ill patients (APACHE II score of 18 or more) with single severe metabolic acidosis (pH<7.20) admitted to the intensive care units (ICUs) of Shri BM Patil Medical College, Vijayapura. Arterial blood gas analysis along with other relevant investigations was done within first 24 h of ICU admission.
Results: Among 50 patients, 32 patients expired compared to 18 patients who were discharged from hospital in stable condition. Out of 29 patients, who had lactic acidosis, 21 (72%) patients died compared to 8 (28%) patients who were discharged in stable condition. Out of 22 patients who have low Strong Ion Difference (SID) 16 patients had expired (76%) remaining 6 (24%) patients are discharged at stable condition. Out of 27 patients who were put on mechanical ventilator on the first day, 22 (80%) patients expired. 18 patients required vasopressor support on admission out of which 16 (90%) patients had lactic acidosis.
Conclusions: Lactic acidosis and strong ion gap are found to be associated with higher mortality. Hypotensive patients required vasopressor support on admission. Monitoring of serum pH, HCO_3^-, lactate levels and strong ion gap may have prognostic and therapeutic implications.

Keywords: Acid-base disorders, Critical illness, Metabolic acidosis

INTRODUCTION

Acid-base abnormalities are associated with high morbidity and mortality irrespective of etiology and are common in critically ill patients. Acidosis in critically ill patients may occur dueto a rise in arterial partial carbon dioxide tension ($PaCO_2$), i.e. respiratory acidosis or due to fixed acids, i.e. metabolic acidosis.[1] Certain types of metabolic acidosis are strong independent predictors of mortality in critically ill patients and should be monitored in intensive care units.[2] There is a difference between patients with respiratory acidosis and those with metabolic acidosis vis-a-vis physiological variables and clinical outcomes prompting some researchers to conclude that it is the cause of acidosis rather than the acidosis per se that determines the clinical outcomes.[2,3] Metabolic acidosis may be due to an increase in endogenous acid production (such as lactate and ketoacids), loss of bicarbonate (as in diarrhea), or accumulation of endogenous acids (as in renal failure). Common causes of metabolic acidosisinclude lactic acidosis, hyperchloremic acidosis, renal failure, and ketoacidosis. Metabolic acidosis can be broadly classified

based on anion gap as normal anion gap metabolic acidosis and high anion gap metabolic acidosis. This classification has therapeutic implications also. Metabolic acidosis is called "severe" when pH<7.20 (metabolic acidosis with pH<7.20 is severe metabolic acidosis).[4] Even though metabolic acidosis is common in the intensive care units (ICUs), data on severe metabolic acidosis are scanty.

METHODS

It was a prospective observational study. We have taken Institutional ethics committee approval for study. This study was undertaken at Shri BM Patil Medical College Vijayapur, a constituent college of BLDE University, Vijayapur, Karnataka State, South India from January 2020 to August 2020.

We took written informed consent from all cases. Apache score was calculated for each patient on the day of admission to ICU using Apache II scoring system. Critically ill adult patients above the age of 18 years admitted in ICUs. Apache II score of 18 or more were considered for the study. Cases who were found to have single severe metabolic acidosis with pH<7.20 on first 24 hour of admission were included for the study. Critically ill patients with single respiratory acidosis and mixed acidosis were excluded. Arterial blood gas (ABG) analysis done within first 24 hour of admission into the ICU were taken and patients in critical care areas with single severe metabolic acidosis with pH<7.20 on first 24 h of admission were enrolled.

Age, gender, presenting symptoms and signs, diagnosis, relevant investigation reports, treatment and intravenous fluids used, duration of stay in ICU and any complications thereof, any new developments in ICU, use of mechanical ventilation and its duration and mortality in the ICU, initial pH levels, initial HCO3− levels, serum lactate levels,

anion gap, APACHE II score and mortality, etc were considred as study variables. This study included 50 such patients during a period of 1 years.

Inclusion in the study would not affect the routine patient care in the ICU. Patients were followed up until discharge (from ICU) or death. Quantitative data are represented as mean±standard deviation. All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean±SD were used.

For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square ($\chi2$) test was used for association between two categorical variables. The difference of the means of analysis variables between two independent groups was tested by unpaired t test. If the p value was<0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analyzed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office 2007.

RESULTS

Out of the total 50 patients, a total of 28 patients were males and 22 were females. Mean age of presentation was 56.2±17.05 years for males and 59±17.81 years for females. Out of 50 critically ill patients with single severe metabolic acidosis (pH<7.20), the average pH value was 6.9 with lowest being 6.6 and highest being 7.12. Mean duration of ICU stay was 4±1 day.

Table 1: The knowledge about the disease caused by dog bite (n=111).

pH	Survived		Not survived		P value
	Mean	SD	Mean	SD	
Day 1	7.0	0.1	6.9	0.1	0.166

Table 2: Distribution of apache II score among survived and non-survived patients.

Parameters	Survived		Not Survived		P value
	Mean	SD	Mean	SD	
Apache II score	19.9	1.0	21.1	0.9	<0.001*

* significant at 5% level of significance (p<0.05)

Table 3: Distribution of mean lactate among survived and non-survived patients.

Lactate	Survived		Not Survived		P value
	Mean	SD	Mean	SD	
Day 1	1.7	0.5	2	0.4	0.143

Results show that in Table 1 out of total 50 cases who had single severe metabolic acidosis (pH<7.2) on admission, 32 cases expired, and 18 cases were discharged in stable condition. Severe metabolic acidosis on admission is associated with significant mortality in critically ill

patients (p=0.001). The mean pH in survived patient is 7.0 in expired patient is 6.9.

Out of 50 patients, 39 patients had Apache II score of >20 and 11 patients had Apache II score between 18 and 20. Of

the 39 patients who had Apache II score more than 20, 28 patients expired (72.7%) compared to 9 patients (27.8%) who were discharged with stable condition (Table 2)

which is statistically significant (p=0.001). The mean Apache II Score in survived is 19.9 and the mean score for expired patients is 21.1

Table 4: Distribution of mean strong ion gap among survived and non-survived patients.

Strong ion gap	Survived		Not survived		P value
	Mean	SD	Mean	SD	
Day 1	37.1	0.9	33.0	1.2	<0.001*

*significant at 5% level of significance (p<0.05)

Out of 29 patients who had high lactate levels, 21 (72%) patients expired and 8 (28%) patients were discharged in stable condition (Table 3).

Table 4 show that out of 22 who have low strong ion difference (SID) 16 (76%) patients had expired and remaining 6 (24%) patients discharged with stable condition.

Most common cause of severe metabolic acidosis in present study was found to be lactic acidosis which is due to sepsis with septic shock. Most common diagnosis in patients with non-lactic acid metabolic acidosis was diabetic ketoacidosis.

DISCUSSION

The strong correlation between the SIG, the albumin- and lactate corrected anion gap provides an exact way of quantifying metabolic acidosis.[3] Severe metabolic acidosis is very widespread among critically ill patients. Jung et al.[5] reported higher chance of mortality in critically ill patients with severe metabolic acidosis.

In our study, severe metabolic acidosis within critically ill patients was associated with mortality significantly, i.e. 64% patients expired compared to 36% patients who were discharged in stable condition (P <0.05) which is steady with the study by Jung et al serum lactate levels may be considered as an important prognostic marker in metabolic acidosis and when elevated pH is associated with higher mortality levels.[5] Gunnerson compared outcomes in patients with high lactate levels and normal lactate levels and established significant mortality association in patients with high lactate level.

Smith et al reported similar findings.[6] In the present study, lactic acidosis is associated with higher mortality compared to non-lactic acidosis cases and higher serum lactate levels are associated with statistically significant mortality (p=0.04) which is consistent with previous studies. In our study we have observed that low strong ion difference (SID) also associated with high mortality. Therefore, it can also be used as predictor of mortality in critically ill patients.[7]

The uncertainty over the timing and indications of bicarbonate buffer therapy and the controversy regarding the pros and cons of bicarbonate therapy was highlighted

in an online survey by Kraut and Kurtz.[8] Gehlbach and Schmidt reported high mortality after bicarbonate therapy and Stacpoole reported higher mortality in lactic acidosis with bicarbonate therapy.[9,10] Jung et al reported no significant outcome between patients who received bicarbonate therapy and patients who did not receive it.[5] Bicarbonate therapy in acute high anion gap metabolic acidosis is controversial.[11,12] From the time of its conception, this study was never meant to assess the effect of sodium bicarbonate on the outcome or to explore the reasons for sodium bicarbonate administration. However, the present study may be helpful as a primer to design a future interventional, randomized study to examine the effects of buffers in severely acidotic critically ill patients.

Limitations

This study focused on only single severe metabolic acidosis excluding mixed acidosis. Whether metabolic acidosis is an etiologic contributor to organ dysfunction or just a marker of severity of underlying illness has been a matter of debate. Severe metabolic acidosis may also play a contributory role in organ dysfunction, decreased cardiac output, arterial dilatation and hypotension, arrhythmia, impaired oxygen delivery, increase in respiratory muscle workload, decrease in adenosine triphosphate generation, and altered immune response. In this context, a more detailed multicentre study with bigger sample size may show more light on possible pathways of functioning of metabolic acidosis.

CONCLUSION

This study emphasizes on the magnitude of severe metabolic acidosis on admission in critically ill patients admitted to ICUs under the Department of General Internal Medicine of BLDE Hospital, Vijayapura, Karnataka, India. Severe metabolic acidosis in critically ill patients is associated with significant mortality. Higher serum lactate levels and low strong ion difference (SID), on admission, are good predictors of mortality. Patients with higher Apache II score on admission were found to be with high mortality. Most common diagnosis in patients with severe metabolic acidosis in the present study is lactic acidosis. Most common diagnosis in patients with lactic acidosis in the present study is sepsis with septic shock. Most common diagnosis in patients with non-lactic acid metabolic acidosis was diabetic ketoacidosis.

Early recognition of mortality predictors may result onto the better outcome of the patient. Whether severe metabolic acidosis in critically ill is a significant abnormality in itself contributing to the causality of complications and mortality, which needs to be corrected, or is it just an association with underlying severe illnesses is difficult to determine and require further research.

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