

# Efficacy of Arterial Blood Gas Analysis on Admission in Predicting the Morbidity and Mortality in Acute Pancreatitis

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## Abstract

**Introduction:** Early diagnosis and prognostic evaluation are important in deciding management in acute pancreatitis (AP) to reduce morbidity and mortality. Several multifactorial scoring systems exist to assess prognosis, but these are cumbersome to recollect and consume 48 h. In this study, arterial blood gas analysis (ABG) was used as a parameter to evaluate the efficacy in predicting the morbidity and mortality in AP.

**Objective:** The objective of the study was to test the predictive efficacy of ABG analysis, at presentation, as a predictor for morbidity and mortality in patients with AP.

**Materials and Methods:** Sixty-five patients with the diagnosis of AP were enrolled in the study. Blood sample was taken for ABG analysis at admission. The severity was assessed based on the duration of hospitalization, need for intensive care unit (ICU) admission, organ failure, local complications, need for surgery/intervention and mortality. The association between various parameters of ABG analysis and severity of illness was analyzed.

**Results:** About 83.3% patients who died of AP, had pH <7.35. All had bicarbonate <22 and a base deficit of > -4 on admission. 50% of patients requiring ICU admission had acidosis at the time of admission, 94.1% had bicarbonate <22 and 82.4% had a base deficit > -4. 66.7% patients who developed renal failure had a pH <7.35 on admission and all of them had a  $\text{HCO}_3^-$  < 22 and a base deficit > -4. 50% of patients who developed respiratory failure, had pH <7.35 on admission, 91.7% had  $\text{HCO}_3^-$  <22 and 75% of them had a base deficit of > -4. 52.6% patients who developed shock had a pH <7.35 on admission, 100% had  $\text{HCO}_3^-$  <22 and 84.2% had a base deficit > -4. Bicarbonate levels <22 on admission predicted the development of acute fluid collection in 78.9% of the patients. Low bicarbonate levels and a base deficit on admission were useful in predicting necrotizing pancreatitis in 100% and 90.4% of patients, respectively. All 9 patients who required percutaneous drainage had bicarbonate <22 on admission.

**Conclusion:** ABG is a simple, inexpensive and useful test which on admission will predict if the patient requires an intensive monitoring.

**Key words:** Acute pancreatitis, Arterial blood gas analysis, Metabolic acidosis

## INTRODUCTION

Acute pancreatitis (AP) is a potentially lethal disease with increasing incidence. 20% of patients with AP develop severe disease with case mortality rate of 14.8%.<sup>[1]</sup> Incidence varies from 4.5 to 79.8 per 100,000 per year in different countries.<sup>[2]</sup> At All India Institute

of Medical Sciences, New Delhi, about 55 patients get admitted per year with AP.<sup>[3]</sup> Patients who develop persistent organ failure within the first few days of the disease are at increased risk of death, with a mortality reported to be as great as 36–50%.<sup>[4]</sup> The development of infected necrosis among patients with persistent organ failure is associated with an extremely high mortality.<sup>[5,6]</sup>

Early diagnosis and prognostic evaluation are important in deciding management of the patient to reduce morbidity and mortality. A delay of transfer to intensive care unit (ICU) >24 h after admission is associated with a four-fold increased mortality risk. Several multifactorial scoring systems exist such as Ranson, Glasgow, Imrie, and Acute

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Physiology and Chronic Health Evaluation II (APACHE II), including various clinical and biochemical factors to assess prognosis but these are complex, cumbersome to recollect and consume 48 h. C-reactive protein (CRP) assays are readily available, and levels rise with disease severity. Based on the trajectory of CRP levels, however, this marker is useful to identify severe disease only 48 hours after the onset of symptoms.<sup>[7]</sup> Other inflammatory mediators such as interleukin (IL)-8 and IL-6 have shown promise as early indicators of severe disease, but await general availability and further clinical validation.<sup>[8]</sup> Other inflammatory markers, including tumor necrosis factor soluble receptors, polymorphonuclear elastase, serum procalcitonin, soluble IL-2 receptors, and soluble E-selectin, have shown potential in the investigative setting but await the availability of reproducible assays as well as clinical validation before their use as prognostic indicators.<sup>[9]</sup> Trypsinogen activation peptide is an additional marker that may be useful in determining prognosis in AP. It is released with the activation of trypsinogen to trypsin, and plasma and urine levels are known to correlate with the severity of pancreatitis. However, the molecule is present in low concentrations of urine and is cleared rapidly from plasma.<sup>[10,11]</sup>

The recently advocated prognostic parameters are expensive tests to be done as a routine. Arterial blood gas analysis (ABG) is a simple diagnostic test, and its parameters have not been evaluated enough to predict outcome and severity in pancreatitis. In this study, ABG will be used as a parameter to evaluate the efficacy in predicting the morbidity and mortality in AP.

### Objective

The objective of the study was to test the predictive efficacy of ABG analysis, particularly arterial pH, bicarbonate levels and base deficit at presentation, as a predictor for morbidity and mortality in patients with AP.

## MATERIALS AND METHODS

Sixty-five patients admitted to MS Ramaiah Hospital from December 2014 to May 2016 with the diagnosis of AP, fulfilling the inclusion and exclusion criteria were enrolled in the study after obtaining informed consent. Blood sample was taken for ABG analysis at admission and was followed up till clinical recovery or death due to the disease. The severity was assessed based on the duration of hospitalization, organ failure (Modified Marshall scoring system for organ dysfunction-annexure 1), local complications (fluid collections, organized necrosis), need for surgery/intervention and mortality. The baseline demographic data, which includes age, sex, occupation, education status, habits, socioeconomic status, and treatment history were taken.

### Inclusion Criteria

Age >16 years, clinical history suggestive of AP with serum amylase >3 times upper limit of normal value or elevated serum lipase and/or positive abdominal imaging (ultrasound or computed tomography abdomen) were included in the study.

### Exclusion Criteria

Patients receiving treatment before presentation, coronary artery disease/pre-existing cardiac disorder, diabetes mellitus, renal failure, malignancy, pregnancy, chronic obstructive pulmonary disease, underlying chronic pancreatitis, pancreatic malignancy (based on history), underlying acid-base disorder, and presenting >10 days after the onset of pain and patient refusing consent.

The patients were categorized into subgroups based on the arterial pH (pH <7.35 and >7.35), bicarbonate levels (<22 and >22 mEq/L), and base deficit values (>-4 mEq/L and <-4 mEq/L, respectively).

### Statistical Analysis

Data were analyzed using SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1. The relationship between abnormal ABG parameters and requirement for ICU admission, duration of ICU care, development of complications, need for surgical intervention and mortality was analyzed. Descriptive and inferential statistical analysis was performed in the present study. Results on continuous measurements are presented on the mean  $\pm$  standard deviation (min-max), and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. The following assumptions on data are made, (1) dependent variables are normally distributed and (2) samples drawn from the population are random, cases of the samples are independent. Chi-square/Fisher Exact test was used to find the significance of study parameters on a categorical scale between two and more groups, non-parametric setting for qualitative data analysis.

## RESULTS

Fifty patients (76.9%) were males, and 15(23.1%) were females. The etiology was alcohol consumption in 46.2% ( $n = 30$ ) and gallstone disease in 16.9% ( $n = 11$ ). The other causes included idiopathic, postviral, hypertriglyceridemia, and mixed etiology. Average length of hospital stay was 10 days. 34 patients (52.3%) required intensive care. 15 patients (23.1%) developed renal failure, 24 patients (36.9%) developed respiratory failure and 19 patients (29.2%) developed shock. 16 patients (24.6%) developed acute fluid collections (AFCs) and 9 patients (13.8%) required percutaneous drainage (PCD)

[Figure 1]. 5 patients (7.6%) required open pancreatic necrosectomy and 6 patients (9.2%) succumbed to their illness.

The patients who presented with metabolic acidosis (MA) at the time of admission were 29.2%, 66.2% had bicarbonate <22 and 55.4% had a base deficit < -4 [Table 1].

Five out of the six (83.3%) patients who died of AP, had pH <7.35, this was statistically significant (P = 0.007). All 6 patients had HCO<sub>3</sub><sup>-</sup> <22 and a base deficit of > -4 on admission [Figure 2].

Fifty percent (17/34) of patients requiring ICU admission had acidosis at the time of admission, 94.1% had HCO<sub>3</sub><sup>-</sup> <22 and 82.4% (28/34) had a base deficit > -4. All these values were statistically significant. 10 out of the 15 (66.7%) patients who developed renal failure as a complication of AP, during the course of the hospital stay, had a pH <7.35 on admission and all of them had a HCO<sub>3</sub><sup>-</sup> <22 and a base deficit > -4. 50% (12/24) of patients who developed respiratory failure, had pH < 7.35

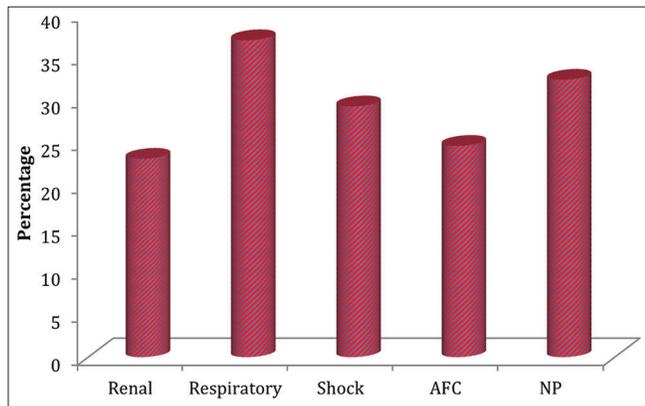


Figure 1: Complications; acute fluid collection, necrotising pancreatitis

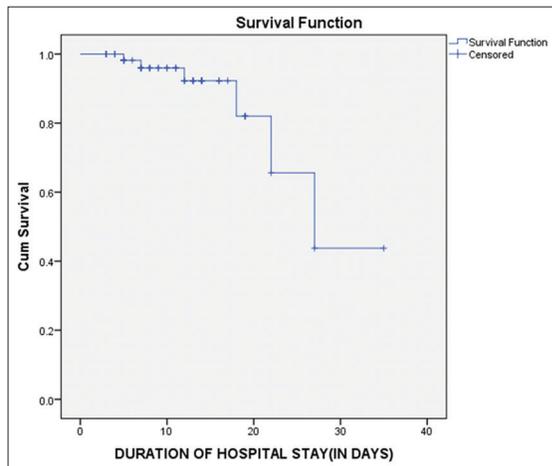


Figure 2: Kaplan Meier curve showing survival function

on admission, 91.7% (22/24) had HCO<sub>3</sub><sup>-</sup> <22, and 75% (18/24) of them had a base deficit of > -4. All of these were statistically significant. 10 out of 19 (52.6%) patients who developed shock had a pH <7.35 on admission, all the 19 patients (100%), had HCO<sub>3</sub><sup>-</sup> <22 and 84.2% (16/19) had a base deficit > -4. All of these were statistically significant. Bicarbonate levels <22 on admission predicted the development of AFC in 78.9% (15/16) of the patients and this was statistically significant (P = 0.007). Low bicarbonate levels and a base deficit on admission was useful in predicting necrotizing pancreatitis in 100% (n = 21) and 90.4% (19/21) of patients, respectively. All 9 patients who required PCD had bicarbonate <22 on admission, and this was statistically significant (P = 0.023).

## DISCUSSION

The development of organ failure, whether at admission or thereafter, implies a worse prognosis. The highest mortality is among patients with multiple and persistent organ failures.<sup>[12,13]</sup> In the present series, 34 patients (52.3%) required intensive care. 15 patients (23.1%) developed renal failure, 24 patients (36.9%) developed respiratory failure, and 19 patients (29.2%) developed shock. 16 patients (24.6%) developed AFCs, 9 patients (13.8%) required PCD, 5 patients (7.6%) required open pancreatic necrosectomy, and 6 patients (9.2%) succumbed to their illness. In a study conducted by Sharma *et al.*, organ failure developed in 71.2% patients and 83.9% had local complications. In 18% of patients, endoscopic/radiological/surgical interventions were needed, and 14.6% died. The patients (n = 35) with MA (pH <7.35) suffered higher frequency of organ failure, need for interventions and mortality. Patients with low arterial bicarbonate levels, as well as the higher base deficit, also displayed a higher frequency of organ failure, need for interventions and mortality. These results were comparable to those obtained in this study.

Studies of factors at admission, that predict the need for intervention, are scarce. A meta-analysis by the Dutch pancreatitis study group, which included

Table 1: ABG parameters on admission

Parameter	Number of patients n=65 (%)
Ph	
7.35	19 (29.2)
>7.35	46 (70.8)
HCO <sub>3</sub>	
<22	43 (66.2)
>22	22 (33.8)
Base deficit	
> -4	36 (55.4)
< -4	29 (44.6)
Total	65 (100.0)

ABG: Arterial blood gas

384 patients, reported that the presence of organ failure and infected pancreatic necrosis could predict the need for intervention.<sup>[14]</sup> A subset of patients among those managed by the step-up approach will still require surgery. A prospective study included 70 consecutive patients with severe AP to identify factors that could predict surgical intervention after initial management with PCD. Reversal of sepsis within a week of PCD, APACHE II score at first intervention, and organ failure within a week of the onset of disease could predict the need for surgery in the early course of the disease. The number of patients with MA (pH <7.2) and base deficit >5 mEq/L at admission was significantly higher in the pancreatic necrosectomy group, compared with the PCD-alone group, and may predict failure of PCD.<sup>[15]</sup> Studies in intensive care settings have documented the effects of MA on mortality. MA (bicarbonate level of <18 mEq/L) was seen in 23 out of 71 AP patients (32%) in a Brazilian study.<sup>[16]</sup> A study of 107 patients admitted to intensive care for various reasons demonstrated a significantly severe MA in non-survivors.<sup>[17]</sup> Another study reported that severe metabolic or mixed acidemia-defined by plasma pH lower than 7.20-occurs within the first 24 h in the ICU in 6% of critically ill patients, and was associated with high rates of mortality in patients admitted to ICU.<sup>[17,18]</sup> In a prospective, observational study of a large cohort of 530 patients, pH at presentation predicted not only long-term mortality but also ICU admission, in-hospital mortality, and mortality after 30-day follow-up.<sup>[19]</sup> Patients with a pH level of <7.39 showed a mortality rate of 37% after 12 months. The association of pH and mortality was independent of other predictors, both in patients with pulmonary and other causes of acute dyspnea.

Although many parameters, including serum creatinine, hematocrit, obesity, blood urea nitrogen, C-reactive protein, serum procalcitonin, and D-dimer, have been studied previously, the present study is important because a detailed evaluation of ABG in AP has not previously been reported. Our results suggest that pH, low bicarbonate and higher base deficit at presentation predicts an adverse outcome and worse prognosis in patients with AP, including the occurrence of organ failure, need for intervention and mortality. Therefore, carrying out an ABG in patients with AP not only helps in the management of patients but also may predict the outcome.

## CONCLUSION

On admission arterial blood gas in a patient diagnosed to have AP is a useful test to predict if the patient will require ICU care, will develop complications due to pancreatitis such as renal, respiratory failure, shock, or require an intervention due to the complications. In our study, it was also seen that patients with deranged ABG parameters

on admission had higher mortality rates. In conclusion, ABG is a simple, inexpensive and useful test which on admission will predict if the patient requires an intensive monitoring. This will help us anticipate which patients require closer observation and intensive monitoring which in turn will reduce mortality rates.

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## ANNEXURE 1

### Modified Marshall scoring system for organ dysfunction

Organ system	Score	0	1	2	3	4
Respiratory ( $P_{aO_2}/F_{iO_2}$ )		>400	301–400	201–300	101–200	≤101
Renal*						
(serum creatinine, $\mu\text{mol/l}$ )		<134	134–169	170–310	311–439	>439
(serum creatinine, mg/dl)		<1.4	1.4–1.8	1.9–3.6	3.6–4.9	>4.9
Cardiovascular		>90	<90, fluid responsive	<90, not fluid responsive	<90, pH < 7.3	<90, pH < 7.2
(systolic blood pressure, mm Hg)†						
For non-ventilated patients, the $F_{iO_2}$ can be estimated from below						
Supplemental oxygen (l/min)	$F_{iO_2}$ (%)					
Room air		21				
2		25				
4		30				
6–8		40				
9–10		50				

A score of two or more in any system defines the presence of organ failure. \*A score for patients with pre-existing chronic renal failure depends on the extent of further deterioration of baseline renal function. No formal correction exists for a baseline serum creatinine  $\geq 134 \mu\text{mol/l}$  or  $\geq 1.4 \text{ mg/dl}$ . †Off inotropic support