Prediction Of Outcome In Critically Ill Or Emergency Surgical Patients: Comparision Of Ph, Base Deficit/Excess And Anion Gap

Shekhar Chaudhary*, Suresh Singh, Deepak Malviya*****

* Ex-Lecturer, Department Of Anesthesia, Mln Medical College, Allahabad, ** Associate Professor, Department Of Anesthesia, Govt. Medical College, Azamgarh, ***Professor, Department Of Anesthesia, RML Medical College, Lucknow

Abstract: Introduction: Abnormal arterial acid-base balance is among the best predictors of mortality in critically ill patient and early detector of serious conditions. The present study was undertaken to predict the outcome of critically ill patients and to compare various parameters for pH, base deficit/excess, anion gap correlate the prediction of mortality and morbidity of outcome. Method: The present study was conducted among 38 patients of age group 20-69 years of either sex, admitted in emergency and intensive Care unit at Nehru Hospital, BRD Medical College, Gorakhpur. Patients in both groups (19 each) were observed for hemodynamic parameters and biochemical parameters for maximum 3 days. Predicted mortality by LODS at the time of admission and actual mortality on day 3 were also noted. Results: Correlation between predicted mortality by LODS and actual mortality in medically ill patients shows high correlation for pH and moderate correlation for HCO3- and low correlation for anion gap and base excess/deficit. In emergency surgical patients high correlation was observed for pH, HCO3- and base excess/deficit while moderate correlation for anion gap. Conclusion: Measuring the pH, anion gap and base deficit at the time of admission, can predict the mortality rate which is comparable to other scoring systems. Early correction of acid-base alteration is recommended to reduce mortality rate. [Shekhar C NJIRM 2016; 7(6): 13-19]

Key words: LODS, pH, HCO3- and base excess/deficit

Author for correspondence: Dr. Suresh Singh C/O Satya Prakash Chand LIG 152 Phase 4 Rapti Nagar (Behind Janta Inter College) Gorakhpur M: 9532516894 E-Mail: drsureshsingh2007@gmail.com

Introduction: Acid-base disturbances occur very frequently in patients who are critically ill. They may dominate the clinical picture as in severe diabetic ketoacidosis or in renal failure. No satisfactory assessment of the presence and degree of acid-base disturbances can be made without measuring the pH of the blood by the pH electrode. It is imperative that the importance of the pH and acid-base measurements through a blood gas machine using the Satrap technique is universally recognized in all developing countries. Today though many critical care units in the large metropolitan cities of India provide this very necessary facility most critical unit in smaller facility, lack this basis amenity. It is also unfortunate that many doctors dealing with critical care medicine are unable to correctly appreciate the results provided by this technique.

Anticipation and early identification of conditions that alter the body's ability to compensate for acid-base disorders are vital in the management of surgical and critically ill patients.

A clear understanding of metabolic-respiratory interactions and a systematic approach aimed at identifying the separate components of acid-base disorders not only serves as a diagnostic tool but also helps in formulating therapeutic interventions.[1] The present study was undertaken to predict the outcome of critically ill patients and to compare and correlate the parameters such as pH, base deficit/excess, anion gap, as predictors of mortality and morbidity of outcome.

Methods: The present study was conducted among 38 patients of age group 20-69 years of either sex, admitted in emergency and intensive care unit at Nehru Hospital, BRD Medical College, Gorakhpur after taking permission from Institutional ethical committee. The patients were divided into two groups of 19 each according to the diagnosis of the patients. Group-I consisted of medically ill patients and Group-II consisted of Emergency surgical patients. Verbal informed consent were taken from all the patients. All the patient were observed from the time of admission in the ICU (Day1) to the next 2 days (Day 2 & Day 3). Consent from all the subjects was taken.

All the patients were examined thoroughly and relevant routine as well as specific investigation was done in all the cases continuously for 2-3 consecutive days. Hemodynamic parameters like PR, BP, SpO_2 and ECG were monitored. ABG were done in all the patients every day or according to the emergency. Arterial blood was taken from radial or dorsal pedis artery or any easily accessible artery. The sample was taken in heparinized syringe to prevent coagulation , sample was kept free from bubbles because it can give

false reading. Test were run on the radiometer ABL-555, Blood gas analysis machine (Radiometer, Copenhagn, Denmark) commonly known as the Blood gas, electrolyte and metabolic measurement system. Predicted mortality was calculated by using Logistic organ Dysfunction system (LODS).[2]

Six variables were analyzed; these included neurologic system, cardiovascular system, renal system, pulmonary system, hematology system, hepatic system.

1. Neurology System

Glasgow Coma Score

3-5	=	5 Points
6-8	=	3 Points
9-13	=	1Points
14-15	=	0Points

2. Cardiovascular System

Heart Rate (Beat/min)

<30	=	5Points
30-139	=	0Points
>140	=	1Points

Systolic Blood Pressure

<40	=	5Points
40-69	=	3Points
70-89	=	1Points
90-239	=	0Points
240-269	=	1Points
>270	=	3Points

3. Renal System

Serum Urea

0-0.35 gm/L	=	0 Points
0.36-0.59gm/L	=	1Points
0.60-1.19gm/L	=	3 Points

Serum Urea Nitrogen

0-0.16gm/L	=	0 Points
0.17- 0.27gm/L	=	1Points
0.28-0.55gm/L	=	3 Points
>0.56gm/L	=	5 Points

Serum Creatinine

0-11.9 mg/L	=	0 Points
-12-15.9 mg/L	=	1 Points
>16 mg/L	=	3 Points

Urine output (Lit/24hours)

0-0.49	=	5 Points
0.50-0.74	=	3 Points
0.75-9.9	=	0 Points
>150	=	3 Points

4. Pulmonary System

PaO_2(mmHg)Fio_2

PaO_2(mmHg) on MV or CPAP	=	0 Points
0-149	=	3 Points
>150	=	1 Points
No IPAP no CPAP no MV	=	0 Points

5. Hematology System

WBC (×10^9/L)

0-0.9	=	3 Points
1.0-2.4	=	1Points
2.5-49.9	=	0Points
>or =50	=	1Points

Platelets (×10^9/L)

0-49	=	1Points
>or 50	=	0Points

Hepatic system

Bilirubin

0-19 mg/lit	=	0Point
≥20 mg/lit	=	1Points

Prothrombin time

=N + 0 to 2.9 sec	=	0 Points
>N+3 sec	=	1 Points

Predicated mortality rate was calculated every day with the calculation of the data. After analyzing the risk stratification of every patient it was compared with actual mortality.

For all the patients we examined whether the changes of the logistic organ dysfunction score (LODS) between the first and the third day in the intensive care unit (ICU) could predict death in the ICU. The index Δ LODS = $LOD_3 - LOD_1$ was used to measure the evaluation of the LODS between the first and third day.

Other variables measured, were time and day of admission and discharge from the ICU, main admission diagnosis. All variables recorded prospectively. The study end point was death in the ICU.

Statistical evaluation: Correlation between predicated mortality (LODS) and actual mortality rate was found by applying Pearson product moment correlation co-efficient (r).

It varies from (+1) to (0) to (-1).
Interpretation of r (or correlation co-efficient)
r = 0.8 and above - High correlation co-efficient
r = 0.4 to 0.7 - Moderate correlation co- efficient
r = <0.3 - Absolutely no correlation

Results: Out of 38 patients, 25 patients were males while 13 were females. The male to female ratio was 2:1, youngest patient was 20 years old and eldest was 69 years old. The maximum number of patients were in the age group 60-69 years (28.94%). Septicemia shock was the commonest medical diagnosis (21.0%) while perforative peritonitis was the commonest surgical diagnosis (52.6%).

Table-1: Predicated mortality rate by LODS and actual mortality rate in medically ill patients

Variables	Day-1			Day-3		
	No. of pt.	LODS (%)	ODIN	LODS	ODIN	Actual Mortality rate (%)
pH						
*<7.35	8	62.37	12.5	65.05	15.94	62.50
*7.35-	5	53.30	3.17	64.73	6.26	20.00
7.45	6	64.43	18.02	71.56	37.16	50.00
HCO_3 (mmol/lit)						
*<20	8	53.70	13.41	65.05	16.84	37.50
*20-26	8	66.06	10.45	37.26	3.40	62.50
*>26	3	64.66	17.27	77.32	34.71	33.33
Anion gap (mmol/lit)						
*<12	7	56.74	10.51	88.3	53.48	28.57
*12-16	2	63.50	4.52	46.45	6.70	0.0
*>16	10	62.79	15.86	47.32	9.78	70.00
Base Excess/ Deficit (mmol/lit)						
*< -2	12	57.49	13.72	65.05	15.94	50.00
*-2 to + 2	4	64.65	3.62	43.63	6.26	25.00
*> + 2	3	67.86	19.95	71.5	37.16	66.66

Predicted mortality by LODS was 62.37% in patients who had pH <7.35, and actual mortality was 62.5%, predicted mortality by LODS was 64.43% in patients having pH< 7.45 and actual mortality was 50% and predicted mortality was 53.3% in patients with pH 7.35-7.45 and actual mortality was 20%. Patients with HCO_3- >26 mmol/lit had predicted mortality by LODS was 64.66% and actual mortality was 33.33%. Patients with HCO_3^- >20 mmol/lit had predicted mortality of 53.7%and actual mortality was 37.5% and patients with HCO_3^- 20-26 mmol/lit were having predicted mortality of 66.06% and actual mortality was 62.5%.

Table-2: Predicated mortality rate by LODS and actual mortality rate in emergency Surgical Patients

Variables	Day-1			Day-3		
	No. of pt.	LODS (%)	ODIN	LODS	ODIN	Actual Mortality rate (%)
pH						
*<7.35	4	53.37	24.35	92.0	55.03	25.00
*7.35-7.45	3	55.03	19.27	38.1	2.73	33.33
*>7.45	12	49.78	13.3	83.2	46.68	25.00
HCO_3 (mmol/lit)						
*<20	8	53.3	21.63	87.6	57.47	37.50
*20-26	8	52.75	12.96	38.1	2.73	25.00
*>26	3	58.7	11.61	60.65	18.09	0.0
Anion gap (mmol/lit)						
*<12	11	51.08	18.48	83.2	46.68	27.27
*12-16	5	61.4	12.08	38.1	2.73	40.00
*>16	3	51.83	15.94	45.8	10.20	0.0

Base Excess/ Deficit (mmol/lit)						
*< -2	12	52.54	18.84	47.08	11.44	33.33
*-2 to + 2	4	54.5	15.28	38.1	2.73	25.00
*> + 2	3	58.7	8.1	83.2	46.68	0.0

Patients with anion gap 12-16 mmol/lit had predicted mortality by LODS was 63.5% and actual mortality was 0%, in patients with anion gap >16 mmol/L the predicted mortality by LODS was 62.79% and actual mortality was 70%, in patients with anion gap < 12 mmol/lit the predicted mortality by LODS was 56.74% and actual mortality was 28.5%. Patients with base excess > +2mmol/L had predicted mortality by LODS was 67.86% and actual mortality was 66.66%, Patients with base excess/deficit -2 to +2 mmol/L had predicted mortality by LODS was 64.65% and actual mortality was 25% and patients with base deficit <- 2 mmol/L had predicted mortality by LODS was 57.9% and actual mortality was 50%. (Table 3)

Predicted mortality by LODS was 55.03% and actual mortality was 33.33% in patients with pH 7.35-7.45, and predicted mortality of 53.37% and actual mortality was 25% in patients with pH <7.35 and predicted mortality of 49.7% and actual mortality was 25%in patients with pH >7.45. Predicated mortality by LODS in patients with HCO_3- > 26 mmo/L was 58.7% and actual mortality was 0%, in patients with HCO_3- <20 mmo/L predicted mortality was 53.3% and actual mortality was 37.5% and in patients with HCO_3- 20-26 mmol/L predicted mortality was 52.75% and actual mortality was 25%. The predicted mortality by LODS in patients with anion gap 12-16 mmol/L was 61.4% and actual mortality was 40%, in patients anion gap >16 mmol/L predicted mortality was 51.83% and actual mortality was 0%,28.5%. Patients with base excess>+2 mmol/L had predicated mortality by LODS was 58.7% and actual mortality was 0%, patients with base excess/deficit -2 to +2 mmol/L had predicated mortality by LODS was 54.5% and actual mortality was 25% and patients with based deficit<-2 mmol/L had predicated mortality by LODS was 52.54% and actual mortality was 33.33%.(Table 4)

In medically ill patient's high correlation was found for pH subgroup moderate correlation for HCO_3- subgroup and low correlation for anion gap and base excess/deficit subgroup. In emergency surgical patients high correlation was observed for pH and HCO_3- and base excess/deficit subgroup while moderate correlation for anion gap subgroup. (Table 5)

Table-3: Correlation coefficient (r) between Predicted mortality and actual mortality rate in both groups

Variables	Medically ill Patients	Emergency Surgical Patients
pH	r = 0.89	R= 0.74
HCo_3-	r = 0.47	R = -0.91
Anion gap	r = 0.01	R = 0.69
Base excess/Deficit	r = 0.19	R = - 0.99

Table-4: Distribution of Mortality in Medically ill Patients

Variables	No. of Patient	Patient Expired	Mortality (%)
pH			
< 7.35	08	05	62.50
7.35- 7.45	05	01	20.00
> 7.45	06	03	50.00
HCo_3			
< 20	08	03	37.50
20-26	08	05	62.50
> 26	03	01	33.33
Anion gap			
< 12	07	02	28.57
12-16	02	-	-
>16	10	07	70.00
Base excess/Deficit			
< 12	12	06	50.00
-2 to +2	04	01	25.00
> + 2	03	02	66.66

Patients with maximum mortality 62.5% were seen in pH < 7.35 where 5 out of 8 patients were expired and minimum mortality 20% were seen in pH 7.35-7.45 where 1 to 5 patients were expired. 50% mortality were seen in pH>7.45 where 3 out of 6 patients were died. Maximum mortality of 62.5% was present in patients having HCO_3- 20-26 mmol/lit in which 5 out of 8 patients were died and minimum mortality 33.33% were present in patients having HCO_3-<26 mmol/lit, 37.5% patients died 3 out of 8 patients in HCO_3-<20 mmol/lit. No mortality was seen in patients with anion gap 12-16 mmol/L where no patients were expired out of 2 patients and maximum mortality 70% were present in patients with anion gap >16 mmol/lit where 7 out of 10 patients were expired, Patients with anion gap <12 mmol/lit had mortality of 28.57% where 2 out of 7 patients were expired. Patients with minimum mortality of 25% were present in base excess/deficit -2 to +2 mmol/lit where 1 to 4 patients were expired. Patients with base deficit < -2 mmol/lit had mortality of 50% where 6 out of 12 patients were expired. Maximum mortality 66.66% were present in patients with base excess >+2mmol/lit where 2 out 3 patients were expired. (table 6)

Table-5: Distribution of Mortality in emergency surgical Patients

Variables	No. of Patients	Patients Expired	Mortality (%)
pH			
< 7.35	04	01	25.00
7.35- 7.45	03	01	33.33
> 7.45	12	03	25.00
HCo_3			
< 20	08	03	37.50
20-26	08	02	25.00
> 26	03	-	-
Anion gap			
< 12	11	03	27.27
12-16	05	02	40.00
>16	03	-	-
Base excess/Deficit			
<- 2	12	04	33.33
-2 to +2	04	01	25.00
> + 2	03	-	-

Patients with pH 7.35-7.45 had mortality of 33.33% where 1 out of 3 Patients expired and 3 out to 12 patients were died in pH>7.45 having mortality of 25% same mortality was also seen in pH <7.35 where 1 out of 4 patients were expired. Patients with HCO_3- >26 mmol/L had no mortality, 3 out of 3 patients were survived and maximum mortality 37.5% were present in patients with HCO_3- <20-26mmol/L where 2 out of 8 patients were expired. No mortality was seen in anion gap>16mmol/L where 3 out of 3 patients were survived and 27.27% mortality were seen in patients having anion gap <12mmol/L where 3 out of 11 patients were expired, Patients with anion gap 12-16 mmol/L had mortality rate of 40% where 2 out of 5 patients were expired. No mortality present in base excess > +2 mmol/lit where all the 3 patients survived and maximum mortality of 33.33% were present in patients with base deficit <-2 mmol/lit where 4 out of 12 patients were expired. Patients with base excess/deficit -2 to +2 mmol/lit had mortality rate of 25% where 1 out of 4 patients were expired. (Table 7)

Discussion: Over the last few years, outcome prediction has made its, way into the ICU as a major scientific discipline. Anticipation and early identification of conditions that alter the body's ability to compensate for acid-base disorders are vital in the management of superficial and critically ill patients.

To treat acid-base disorders, it is no sufficient simply to return one or two laboratory parameters to normal value; one must understand the overall course of the disorder as well as the specific forces involved at any particular time. A comprehensive understanding of the Path physiology and Practical approach to bed-side evaluation are complementary component of care and are equally necessary in the management of an acid-base disorder.

The results of this study indicate that correlation between predicted mortality by LODS and actual mortality in medically ill patients shows high correlation for pH and moderate correlation for HCO_3^- and low correlation for anion gap and base excess/deficit. In emergency surgical patients high correlation was observed for pH, HCO_3^- and base excess/deficit while moderate correlation for anion gap.

In comparison, Kaplan et al[3] found that all of the acid-base descriptors were strongly associated with outcome from major vascular injury in an emergency department, but the strong ion gap discriminated most strongly with an area under the receiver

operator characteristic of 0.991 (95% confidence interval, 0.972-0.998). The literature reviewed by Kruse et al[4] supported blood lactate monitoring as being useful for risk assessment in patients admitted acutely to hospital, and especially the trend, achieved by serial lactate sampling, is valuable in predicting in-hospital mortality. Husain et al[5] in their study among surgical intensive care unit patients reported that elevated initial and 24-hour lactate levels were significantly correlated with mortality and appear to be superior to corresponding base deficit levels.

Hobbs et al[6] conducted a retrospective study to evaluate venous blood lactate, base excess, bicarbonate, and pH as predictors of mortality among 84 monkeys with severe traumatic injury and shock. Analysis of the 4 variables after resuscitation therapy indicated that lactate was the only variable significantly associated with survival in their study.

Krishna et al [7] conducted a study among severely injured patients, using base deficit, core temperature and injury severity score, and predicted out come with 92.5% accuracy. Severe hypothermia (<330C), severe metabolic acidosis (base deficit >12 mmol/lit) and a combination (temperature<35.50C and base deficit >5mmol/lit) were strong predictors of death. Kincaid et al [8] found that trauma patients who had persistently high base deficit had a greater risk of MODS and Death. Similar observations were reported by Sauaia et al[9] and Rutherford et al [10].

In a study by Matthew et al [11] among 2291 patients, there were 174 ICU deaths (8%). The admission serum HCO_3 level predicted ICU mortality as accurately as the admission arterial BD (AUCs of 0.68 and 0.70, respectively) and more accurately than either admission pH or anion gap.

Predicted mortality and actual mortality was almost comparable in most of the situations except were pH is normal or at a higher side on admission, HCO_3^- is on a higher side, wider anion gap and more base deficit is present. In these cases actual mortality was found to be much less as compared to predicted mortality. Reason might be in the LODS prediction where all 6 variables are calculated in all the patients but in the present study we analyzed separately pH, HCO_3^- anion gap and base excess/deficits.

Conclusion: Results of present study showed that alternation in pH and anion gap leads to higher mortality rate. So, we concluded that just measuring the pH, anion gap and base deficit at the time of admission, can predict the mortality rate which is comparable to other scoring systems. Early correction of acid-base alteration is recommended to reduce mortality rate.

References:

1. Kellum JA, Kramer DJ, Pinsky AR. Strong ion gap: a methodology for exploring unexplained anions. J Crit Care. 1995; 10: 51-55.
2. Le Gall JR, Klar J, Lemeshow S, Saulnier F, Alberti C, Artigas A, Teres D.. The Logistic Organ Dysfunction system. A new way to assess organ dysfunction in the intensive care unit. ICU Scoring Group. JAMA. 1996; 276(10): 802-10.
3. Kaplan LJ, Kellum JA. Initial pH, base deficit, lactate, anion gap, strong ion difference, and strong ion gap predict outcome from major vascular injury. Crit Care Med. 2004 May;32(5):1120-4.
4. Kruse O, Grunnet N and Barfod C . Blood lactate as a predictor for in hospital mortality in patients admitted acutely to hospital: a systematic review. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2011; 19:74.
5. Husain FA, Martin MJ, Mullenix PS, Steele SR, Elliott DC. Serum lactate and base deficit as predictors of mortality and morbidity. The American Journal of Surgery 2003; 185: 485–491.
6. Hobbs TR, O'Mall JP, Khouangsathiene S, and Dubay CJ. Comparison of Lactate, Base Excess, Bicarbonate, and pH as Predictors of Mortality after Severe Trauma in Rhesus Macaques (Macaca mulatta). Comparative Medicine 2010, 60(3): 233–239.
7. Krishna G, Sleigh JW, Rahman H. Physiological predictors of death in exsanguinating trauma patients undergoing conventional trauma surgery. Aust NZJ Surgery. 1998; 68: 826-829.
8. Kinciad EH, Chang MC, Letton RW, Chen JG, Meredith JW. Admission base deficit in pediatric trauma: a study using the National Trauma Data Bank. J Trauma. 2001; 51: 332-335.
9. Sauaia A, Moore FA, EE, Haenel JB, Read RA, Lezotte DC. Early predictors of postinjury multiple organ failure. Arch Surg. 1994; 129: 39-45.

10. Rutherford EJ, Morris JA, Reed GW, Hall KS. Base deficit stratifies mortality and determines therapy, J Trauma. 1992; 33: 417-423
11. Martin MJ, FitzSullivan E, Salim A , Berne TV, Towfigh S, Stain SC et al. Use of Serum Bicarbonate Measurement in Place of Arterial Base Deficit in the Surgical Intensive Care Unit.Arch Surg. 2005;140(8):745-751.

Conflict of interest: None

Funding: None

Cite this Article as: Shekhar C , Suresh S, Deepak M. Prediction Of Outcome In Critically Ill Or Emergency Surgical Patients: Comparison Of Ph, Base Deficit/Excess And Anion Gap. Natl J Integr Res Med 2016; 7(6): Page no: 13-19