PROPORTION, ETIOLOGY, AND CLINICAL FEATURES IN PATIENTS WITH ANION GAP BASED METABOLIC ACIDOSIS

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ABSTRACT

Objectives: *Determine the rate, cause and clinical characteristics of metabolic acidosis according to the Anion gap (AG) of the patient in the intensive care unit of the Vietnam National Children's Hospital.* ***Subjects and methods:*** *This prospective descriptive study included 168 patients diagnosed with metabolic acidosis in Intensive Care Unit of Vietnam National Children's Hospital from 7/2019 to 7/2020.* ***Result:*** *The number of patients with metabolic acidosis increased Anion gap was 127/168, accounting for 76%. The most common cause of patients with metabolic acidosis is shock, especially septic shock and metabolic disorders. For most groups of causes, the Anion gap usually ranges from 12-20. Symptoms of coma and respiratory failure to support mechanical ventilation remained high, especially in the AG group. The most common group of patients with increased acid production.* ***Conclusion:*** *The rate of patients with metabolic acidosis with increased Anion gap is majority. Relying on the Anion gap and the clinical symptoms may help determine the cause of the disease.*

Keywords: *Metabolic acidosis, anion gap, causes, and clinical features.*

1. INTRODUCTION

Acidosis is a process that occurs due to an increase in production, decrease of acid secretion or loss of a base, and disturbs the body's alkaline balance. The proportion of patients with metabolic acidosis in ICU through the studies ranged from 12-64%, in which patients with severe metabolic acidosis accounted for 8-23% [1] [2] [3] [4]. Metabolic acidosis can be found in many severe conditions, with a variety of clinical manifestations, such as tachycardia, respiratory failure requiring mechanical ventilation, reduction in myocardial contractility and stroke volume, arrhythmia, impaired consciousness. [5] [6]. Severe acidosis can cause many complications and increase the risk of death.

Anion gap (AG) is a commonly used indicator in patients with metabolic acidosis. Anion gap, along with clinical symptoms, helps to orient the cause. In addition, it contributes to the prognosis of severity and mortality in metabolic acidosis [2] [7]. However, there are no studies that go into detail to classify the causes according to the anion gap as well as describe the clinical manifestations for each group of diseases. Therefore, we conduct study with the aim of: To comment on the proportion, cause and clinical characteristics in patients with AG based metabolic acidosis.

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2. STUDY SUBJECTS AND METHODS

2.1. Study subjects

168 patients from 1 month to 15 years old were diagnosed with metabolic acidosis in the intensive care unit of the Vietnam National Children's Hospital. Diagnostic standard for metabolic acidosis: pH <7.38; HCO_3^- <18; BE <-3. Anion gap (AG) is calculated by the formula: AG = Na + - Cl "- HCO_3^-". Patients with AG> 12 were classified as having increased AG [5], [8], [9].

2.2. Study Methods: Describe the study, select convenient samples.

Patients entering the intensive care unit of Vietnam National Children's Hospital, are clinically examined, indicated for tests, blood gas collection at the time of admission, calculation of the anion gap, diagnostic of the cause, treat according to the regimen and follow up post-resuscitation results (life and death / return). The patients were classified into two groups, the increased anion gap and the normal anion gap. Analysis of the cause of metabolic acidosis, clinical characteristics according to the anion gap.

3. STUDY RESULTS

3.1. The proportion of metabolic acidosis according to AG

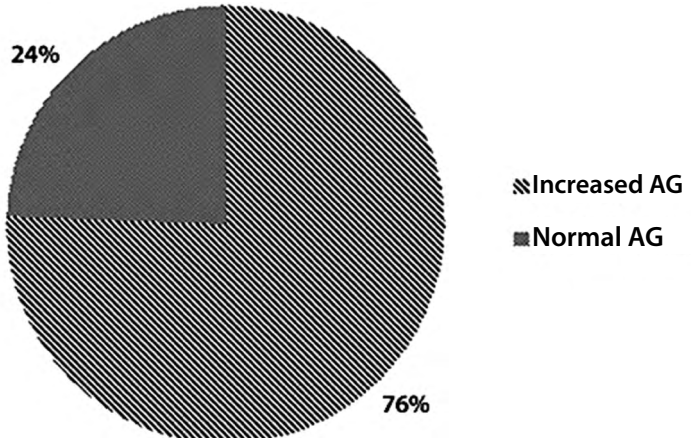

Figure 1. Proportion of patients by AG

Comments: The number of patients with increased AG is 127, accounting for 76%. Patients with normal AG is 71, accounting for 24%.

3.2. AG distribution in patients with metabolic acidosis

Table 1. Distribution of the AG interval in patients with increased AG metabolic acidosis

AG	n	%	% Incremental
12-20	65	51.2	51.2
20-30	42	33.1	84.3
>30	20	15.7	100

Comment: Among patients with increased AG metabolic acidosis, patients with AG from 12-20 accounted for the highest percentage with 65 patients, accounting for 51.2%. Followed by AG group from 20-30 with 42 patients, accounting for 33.1%. The lowest is group AG> 30, with 20 patients, accounting for 15.7%.

3.3. Causes of metabolic acidosis

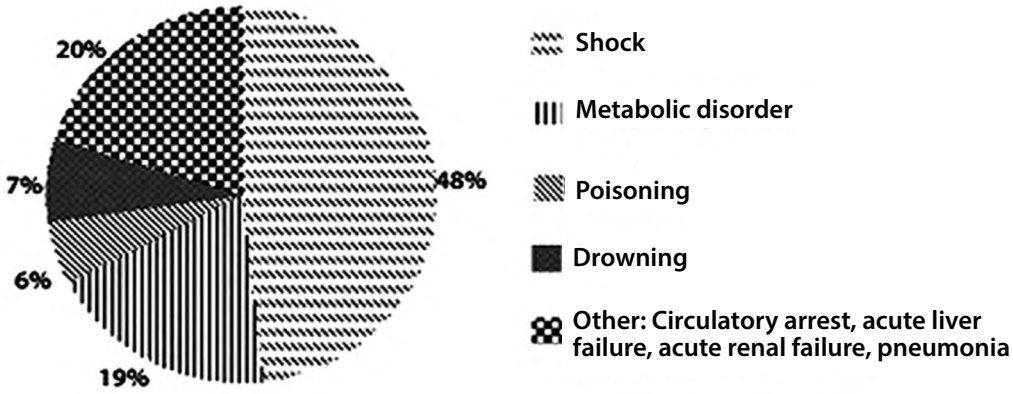

Figure 2. Common causes in patients with metabolic acidosis

Comments: The most common cause was shock, which accounted for 48% of 81 patients. This is followed by metabolic disorders at a rate of 19% in 32 patients. There are also many other causes accounting for a lower rate such as poisoning, ketoacidosis, acute liver failure, acute renal failure.

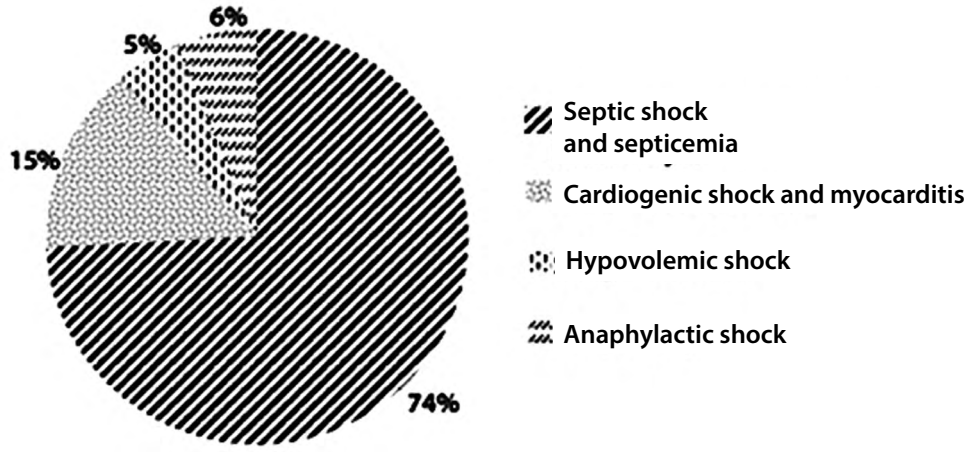

Figure 3. Proportion of shock types in patients with metabolic acidosis

Comment: Septic shock is the most common cause of metabolic acidosis, accounting for 74%. Followed by cardiogenic shock accounts for 15%. Less common are hypovolemic shock and anaphylactic shock.

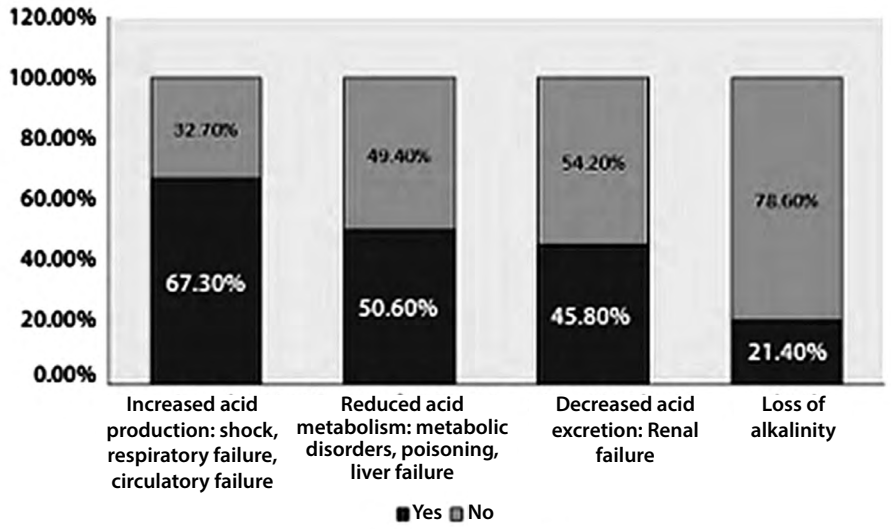

Figure 4. Group of causes of metabolic acidosis

Comments: Patients are mainly in the group of increased acid production with 113/168 patients, accounting for 67.3%. Followed by the group of reduced acid metabolism with 85/168 patients and the group decreased acid secretion with 77/168 patients. The least common group of patients with alkaline loss, with 36/168 patients, accounting for 21.4%.

3.4. Distribution of AG by cause

Table 2. Distribution of AG by cause

AG	Increased acid production: shock, respiratory failure, circulatory failure		Reduced acid metabolism: metabolic disorders, poisoning, liver failure		Decreased acid excretion: Renal failure		Loss of alkalinity: diarrhea	
	N	%	N	%	N	%	N	%
< 12	32	28.3	13	15.3	13	16.9	11	30.6
12-20	39	34.5	35	41.2	29	37.7	12	33.3
20-30	29	25.7	21	24.7	21	27.3	9	25
>30	13	11.5	16	18.8	14	18.2	4	11.1

Comment: Anion gap of cause groups is in the range of 12-20 mainly. In which, the group of reduced acid metabolism has the number of patients with AG in the range 12-20 accounting for the highest proportion, 41.2%. The group of loss of alkaline with AG <12 accounts for a quite high rate with 11/36 patients, accounting for 30.6%. Meanwhile, the group that increased acid production and decreased acid secretion group had AG from 20-30, accounting for 25.7% and 27.3%, respectively, higher than the other 2 groups.

3.5. Clinical characteristics

Table 3. Clinical characteristics in patients with AG-based metabolic acidosis

Clinical symptoms	Both groups (n= 168)		Normal AG(n=41)		Increased AG (n=127)		P
	N	%	N	%	N	%	
Vomit	39	23.2	9	22	30	23.6	0.826
Fever	56	33.3	15	36.6	41	32.3	0.611
Diarrhea	36	21.4	11	26.8	25	19.7	0.332
Convulsions	12	7.1	1	2.4	11	8.7	0.297
Comatose	150	89.3	33	80.5	117	92.1	0.045
Lower blood pressure	62	36.9	9	22	53	41.7	0.022
Refill >2s	83	49.4	14	34.1	69	54.3	0.025
Mechanical ventilation	161	95.8	37	90.2	124	97.6	0.061

Comment: The rate of patients in coma, hypotension, and prolonged refill in patients with AG-elevated metabolic acidosis was higher than in normal AG patients, the difference was statistically significant with p <0.05. Meanwhile, the differences in symptoms such as vomiting, fever, diarrhea, and convulsions in 2 groups were not statistically significant.

Table 4. Clinical characteristics by group of causes

Clinical symptoms	Increased acid production: shock, respiratory failure, circulatory failure		Reduced acid metabolism: metabolic disorders, poisoning, liver failure		Decreased acid excretion: Renal failure		Loss of alkalinity: diarrhea	
	N	%	N	%	N	%	N	%
Vomit	18	15.9	24	28.2	18	23.4	11	30.6
Fever	50	44.2	24	28.2	27	35.1	20	55.6
Diarrhea	28	24.8	18	21.2	19	24.7	36	100
Convulsions	8	7.1	6	7.1	7	9.1	1	2.8
Comatose	103	91.2	78	91.8	69	89.6	29	80.6
Lower blood pressure	37	32.7	37	43.5	32	41.6	12	33.3
Refill >2s	65	57.5	41	48.2	40	51.9	22	61.1
Mechanical ventilation	110	97.3	83	97.6	73	94.8	34	94.4

Comments: The proportion of patients with symptoms of fever, vomiting, and diarrhea accounted for a high proportion in the alkaline loss group, 30.6%, 55.6% and 100%, respectively. Meanwhile, symptoms of neurological failure such as convulsions, comatose were higher in the other 3 groups. Hypotension is seen with a high rate in patients with reduced acid metabolism with 37/85 patients, accounting for 43.5%. The prolonged refill symptom was common in the group of increased acid production and loss of alkalinity, accounting for 57.5% and 61.1%, respectively. Most of the patients in the groups had to support ventilation with rates above 90%.

4. DISCUSSION

4.1. The rate of AG based metabolic acidosis

In the Intensive Care Unit, children with metabolic acidosis with increased anion gap accounted for a high proportion of 127 patients, accounting for 76% of patients in the study. This result is similar to the study of Phi Duc Long and Pham Van Thang, with the rate of 73.58% in the group with increased AG [1]. Meanwhile, according to study by Lolekha et al., this proportion only accounts for 46.7% of study patients [10]. This difference can be explained for 2 reasons, firstly, our sample size is different, secondly, Lolekha studied on all patients admitted to hospital, not in the ICU as the our study.

4.2. Distribution of AG interval in patients with metabolic acidosis

Table 1 shows that in the group of patients with increased AG, the proportion of patients with AG 12-20 accounted for the highest 51.2% with 65 patients, followed by the group of patients with AG 20-30 accounting for 33.1%, the lowest is the group of patients with AG >30, accounting for 15.7%. This result is similar to the study of Lolekha et al. (1983), with 42% of patients with AG between 19-21, and AG> 30 accounting for 6% [10]. Another study also by Lolekha et al (2001), also shows that the group of patients with AG from 13-18 accounting for the highest proportion of 84.7% [11]. Thus there is a similarity between the results of our study with others in the world.

4.3. Causes of metabolic acidosis

Our study shows that metabolic acidosis is most common in patients in shock, accounting for 48%, especially septic shock and sepsis accounts for 74%. This result is different from the study of Phi Duc Long and Pham Van Thang when the number of patients infected with sepsis accounts for only 15.38%. While the study of Lolekha et al in 1983 and 2001, the most common cause was urinary tract diseases accounting for 22.5% and 28.4% respectively, mainly chronic kidney failure [10], [11]. According to Min Jung Kim et al., the most common cause is neurological diseases (48.2%) [2]. This difference may be due to the fact that our study subjects are children, the sample size is not large enough and the pathological characteristics of the ICU-admitted patients are mainly in shock.

In our study, the group of most common causes of metabolic acidosis is the group of increased acid production with conditions such as shock, respiratory failure, and circulatory failure. Followed by the group of reduced acid metabolism and less frequently the decreased acid secretion group and the loss of alkaline group.

4.4. Distribution of AG by cause

Table 2 shows that in most groups of causes of increased AG, AG is mainly in the range from 12-20, especially the group of causes of decreased acid metabolism, including metabolic disorders, acute poisoning, and liver failure. In addition, for groups of causes such as increased acid production and decreased acid secretion, AG is mainly in the range 20-30, which can be explained by the severity and acute course of these diseases. This result is similar to the results of Lolekha et al. In most cause groups, the most common AG is from 19-21. However, unlike our study, in Lolekha's study, the group of patients with the highest AG interval was the group of patients with chronic renal failure, with patients with the highest AG up to 40 [10], [11]. This difference may be due to Lolekha's study targeting both adults and children, the number of patients studied is also larger than ours.

4.5. Clinical characteristics

Our study shows that the percentage of patients entering the unit in a coma is high with 150 patients, accounting for 89.3%. This result is different from the study of Phi Duc Long and Pham Van Thang (2002) when the number of patients entering the unit in a coma only

accounts for 50% [1]. It is possible that over the years of medical development, more patients are kept for treatment at the lower levels, patients entered our unit when their condition was very severe beyond the treatment ability of lower levels. In addition, the study also shows that the percentage of patients having to use mechanical ventilation in the first hours is very high, accounting for 95.8%. This result is also higher than the study of Min Jung Kim et al (2017), when the proportion of patients requiring ventilator support was 75.7% [2]. This difference may be due to the different sample sizes and the Vietnam National Children's Hospital, which is the end-line hospital, the patients who come to us are in very serious condition and the timing is usually late.

Table 3 also shows that in the increased AG group, symptoms such as coma, hypotension, and prolonged refill appeared significantly more in the normal AG group.

In our study, patients with alkalosis often had symptoms of fever, vomiting and diarrhea. Meanwhile, neurological failure symptoms were found in groups with similar proportions. Symptoms of hypoperfusion in shock, such as prolonged hypotension or refill, were more common in the group of increased acid production and decreased acid metabolism.

5. CONCLUSION

The percentage of patients with metabolic acidosis with an increase in AG was 76%. Shock, especially septic shock, and metabolic disorders are the two most common causes of metabolic acidosis. In patients with increased AG metabolic acidosis, the AG is usually in the 12-20 range. The proportion of patients admitted to hospital with symptoms of coma and requiring mechanical ventilation assistance remained high, especially in the AG group. The most common group of patients with increased acid production. It is possible to rely on AG and clinical symptoms to orient the group of metabolic acidosis causes.

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